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# Evaluation and Correlation of Steam Solubility Data for Salts and Minerals of Interest in the Power Industry

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## CONTENTS

1.	Introduction . . . . .	1
2.	Boundaries of Study . . . . .	2
3.	Treatment of Data . . . . .	2
4.	Correlating Data . . . . .	3
5.	Sodium Chloride . . . . .	4
6.	Silicon Dioxide . . . . .	5
7.	Sodium Phosphate . . . . .	7
8.	Sodium Sulfate . . . . .	8
9.	Copper Oxides . . . . .	10
10.	Sodium Hydroxide . . . . .	12
11.	Iron Oxides . . . . .	12
12.	Assessment of Extrapolation . . . . .	13
13.	Summary of Solubility Calculations . . . . .	13
14.	Need for New Data . . . . .	14
15.	Bibliography . . . . .	15
Appendix A. Solubility Data . . . . .		A-1
	Cupric Oxide (CuO) . . . . .	A-1
	Cuprous Oxide (Cu <sub>2</sub> O) . . . . .	A-2
	Quartz (SiO <sub>2</sub> ) . . . . .	A-3
	Silica (SiO <sub>2</sub> ) . . . . .	A-11
	Sodium Chloride (NaCl) . . . . .	A-12
	Sodium Hydroxide (NaOH) . . . . .	A-20
	Sodium Phosphate (Na <sub>3</sub> PO <sub>4</sub> ) . . . . .	A-21
	Sodium Sulfate (Na <sub>2</sub> SO <sub>4</sub> ) . . . . .	A-22
Appendix B. Vapor Pressures . . . . .		B-1
Appendix C. Vapor-Liquid Partitioning for Na <sub>3</sub> PO <sub>4</sub> and Na <sub>2</sub> SO <sub>4</sub> . . . . .		C-1
Appendix D. Examination of Extrapolation Behavior . . . . .		D-1
Appendix E. Sample Solubility Calculations . . . . .		E-1

## List of Symbols

A, B, D	coefficients in solubility equations
K	equilibrium constant for hydration reaction
P	pressure, MPa
S	solute species
T	absolute temperature, K
a	activity of a species
m	number of waters in hydration reaction
$m_1, m_2, m_3$	coefficients in solubility equations
s	solid phase
v	vapor phase
$x_s$	solute mole fraction

## Greek Letters

$\rho$	water/steam density, mol/L
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We performed a literature search for data on the solubility in steam of several salts and minerals of interest in the steam power industry. The specific solutes of interest were sodium chloride, sodium hydroxide, sodium sulfate, sodium phosphate, iron oxides, copper oxides, and silicon dioxide. The region of primary interest was temperatures from 300 °C to 640 °C and pressures from 2 MPa to 4 MPa. Some effort was made to choose among discrepant data sets and to assess the level of uncertainty in the solubility determinations. Simple functional forms, expressing the solubility as a function of the temperature and density of pure steam at the experimental conditions, were fit to the data. For solutes where there are no data in the region of interest, various extrapolation methods were used and estimates were made of the uncertainty involved in the extrapolation. A discussion is given of the most critical data needs in this area.

Key words: aqueous solutions; combustion turbine; deposition; mineral; power generation; salt; solid-fluid equilibria; solubility; steam; turbine

## **1. Introduction**

Deposition of solids from expanding steam is a significant concern in the power industry. Deposition in steam turbines is well known. Depending on the deposited material and the location in the turbine, deposits can cause corrosion or constriction of passages. Constriction of passages causes higher pressure drops, reduced efficiency, and reduced capacity. Corrosion can lead to failures and expensive repairs. Investigations into steam purity and the solubility of salts in steam have been in progress for over 50 years [1].

The problem of deposition has developed new urgency as steam cooling is proposed for advanced combustion turbines. In these turbines, some of the passages will be substantially smaller than in the steam turbines. A small amount of deposition can block a passage. When the passage is blocked, the region will overheat and the part will fail. Additionally, the steam will be in contact with substantially hotter metal. Hot corrosion is unknown in steam turbines, but is well

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known in combustion turbines due to higher temperatures. Sodium sulfate is well known as a cause of hot corrosion, where in steam turbines it is only a mild corrodent. Deposition of materials that are benign in steam turbines can cause corrosion in the combustion turbine.

This project was undertaken to collect and, if possible, correlate all available data for the solubility in steam of the following solutes: sodium chloride, sodium hydroxide, sodium sulfate, sodium phosphate, iron oxides, copper oxides, and silicon dioxide. The correlations will be useful in developing steam purity recommendations for the steam conditions encountered in the advanced turbines.

## **2. Boundaries of Study**

The temperature range considered was 200 °C to 900 °C (with 300 °C to 640 °C of primary interest) and the pressure range considered was 1 to 6 MPa (with 2 to 4 MPa of primary interest). These conditions correspond to very low steam densities (on the order of 0.5 to 1 mol/L) at which few reliable data exist. It was therefore necessary to collect and include in the correlations data at higher pressures (and therefore higher densities). Some data sufficiently far from the region of interest were not of any use in the study; the prime example is the abundant data for solubilities of some of these substances in liquid water. While some data in this category were cataloged if they were encountered in the literature search, no attempt was made to be comprehensive except in and near the region of interest.

The work proceeded on the assumption that the solutes remained chemically intact, undergoing no hydrolysis, decomposition, or other chemical reaction. This is not true for some solutes; for example, Galobardes et al. [2] found that hydrolysis was not insignificant at high temperatures in their measurements of NaCl solubility. Sodium sulfate is also known to hydrolyze to some extent and to undergo partial decomposition at high temperatures. Such reactions were ignored on the grounds that considering them would have made the problem intractable and that the reaction products would likely be at least as soluble as the intact solutes, meaning that the assumptions of no hydrolysis or dissociation would probably provide a conservative estimate for solids deposition calculations. For similar reasons, the possible enhancement of the solubility of one solute by the presence of another (for example, the effect of dissolved ammonia on solutes whose solubility is sensitive to pH) was not considered.

Also, the work was limited to the equilibrium solubility. This meant that transport of solutes by mechanical carryover was not considered. It also meant that there was no consideration of kinetic aspects of solute deposition. It is possible for situations to arise where the equilibrium favors precipitation, but the kinetics are such that precipitation will not happen in the time available. Such considerations are beyond the scope of this study, but assuming precipitation when thermodynamically possible is again a conservative assumption in this context.

## **3. Treatment of Data**

All data were entered into a spreadsheet in the units in which they were originally reported. They were then converted to units of temperature in kelvins, pressure in megapascals,

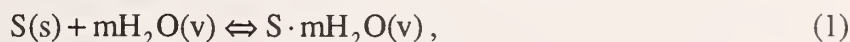


the density of pure water at that temperature and pressure in moles per liter, and the solubility in mole fraction. In most cases, the temperature and pressure were reported and the density of water was calculated from the 1995 IAPWS formulation for the properties of water and steam, hereafter referred to as the Steam Tables [3]. Some data were reported at the vapor-liquid saturation boundary with just temperature or pressure given, in which case the other saturation condition and the corresponding density were calculated from the Steam Tables. In a few cases, the temperature and density were reported and the pressure of pure water was calculated from the Steam Tables. The data tabulations in Appendix A indicate which variables were measured for each data set and the units in which the data were originally reported. It should be noted that these procedures will not exactly match the densities at the experimental conditions, because the PVT behavior of the solid-saturated mixture will not be identical to that of pure water. This mismatch should be small at conditions where the solubility is small (which is for the most part the case in this work), but could be significant at conditions where the solubility is larger.

#### 4. Correlating Data

There are two fundamental ways to describe the solubility of a solid in a gas or supercritical fluid. The first is a physical model, where the volatility (as represented by the fugacity) of the solute is given to a first approximation by its vapor pressure and is then augmented by a Poynting correction (which gives the effect on the fugacity of a condensed substance due to pressure above its saturation pressure) and a fugacity coefficient to account for nonideality in the vapor phase. Fugacity coefficients can be calculated with a variety of models. However, the substances of interest in this work show solubilities in steam many orders of magnitude larger than would be expected based on their vapor pressures. This suggests that the effects governing the solubility are too strong for a physical, fugacity-coefficient-based model. The available vapor-pressure data for each solute are summarized in Appendix B.

The second option is a reaction model, where the solubility is viewed as a complexation between some number of solvent molecules and a solute molecule. This has been the customary approach for describing the solubility of these compounds, and it is the one adopted in this work. If we consider the solute to be solvated by  $m$  solvent molecules, the reaction is written



where  $S$  is the solute. Assuming the activity of the solid to be 1 (which ignores a Poynting correction, but that will be negligible at low and moderate pressures, especially at the relatively high temperatures of interest here), the thermodynamic equilibrium constant  $K(T)$  for that reaction can be written as

$$K(T) = \frac{a(S \cdot mH_2O)}{[a(H_2O)]^m}, \quad (2)$$

where  $a$  is the activity. At this point things become difficult. The activity of pure water is just its fugacity, but there is no way in general to predict or describe the activity of the hypothetical hydrated solute complex. We must therefore begin making reasonable approximations. The first

is to replace the activity of the complex by some direct measure of how much solute is dissolved, such as its mole fraction or partial pressure. Second, it has been found that better correlations are obtained by replacing the activity of water with its density. This leads to equations of the form

$$\ln(x_s) = f(T) + m \ln \rho_{H_2O} \quad (-\ln P), \quad (3)$$

where  $x_s$  is the mole fraction of solute,  $\rho_{H_2O}$  is the density of the solvent water and the last  $(-\ln P)$  term is only included if partial pressure (rather than mole fraction) is used to express the amount of solute. The function  $f(T)$  is no longer the thermodynamic equilibrium constant, but now also has to make up for other approximations in the model. The hydration number  $m$  could in general be a function of density and/or temperature.

## 5. Sodium Chloride

NaCl has by far the most solubility measurements of any substance of interest in this work in the region of interest. Most of the measurements are in good agreement at densities above 2 mol/L; below that, the measurements diverge considerably. Data considered were restricted to steam densities below 10 mol/L. The data of Alekhin and Vakulenko [4] were excluded because their values were about two orders of magnitude above those of the vast majority of investigators. Others have observed [5, for example] that their experimental setup might be prone to adsorption effects. The data of Sourirajan and Kennedy [6] were about one order of magnitude above those of other investigators and show a very different trend with density than what others observe; these data were also excluded. Finally, the early data of Spillner [1] were excluded; they fell somewhat above the general trend and exhibited a large amount of scatter. This resulted in 12 references [2, 5, 7-16] being used in the fit.

At densities below 2 mol/L, there is a dichotomy in the data. Some data show a continuous steep decrease in solubility with decreasing density, while other (primarily Russian) data indicate that the solubility levels off or at least decreases less quickly. Shvedov [17] suggested that at least some of the latter data, because they were based on measurements of chloride concentration, are artificially high due to the production of HCl by hydrolysis. For this reason, and because it was a more conservative estimate in the context of potential precipitation from steam, we chose to fit the data in this region with the lower solubilities. We therefore excluded the low-density (again below 2 mol/L) data of Martynova and Samilov [12] and Styrikovich et al. [8], and also the low-temperature (at and below 402 °C) low-density data of Sastry [11] and the low-temperature (below 400 °C) data of Bischoff et al. [15]. In addition, to avoid giving undue weight to the data from Sastry [11] in which over 200 points were reported, those points not excluded from the fit were given a weight of 0.2 relative to the other data. Similarly, the approximately 50 points along a single isobar by Aleinikov et al. [9] were each given a weight of 0.5.

The data were fit to a simple equation of the form

$$\ln(x_s) = A + B / T + (m_1 + m_3 / T) \ln \rho - \ln P, \quad (4)$$



with values of  $A = -7.928\,86$ ,  $B = -4852.47$ ,  $m_1 = 4.499\,61$ , and  $m_3 = -0.0013$ . In eq (4), the temperature must be in K, the density in mol/L, and the pressure in MPa.

Figure 1 shows the range of temperature and density covered by the NaCl solubility data (data sets that were discarded completely are not included in the figure). Figures 2 and 3 show the deviations of the experimental data from the predicted values of  $\ln(x_s)$  as a function of density and of temperature for eq (4). Figures 4 through 7 show how the data are fit along four isotherms (where an isotherm is defined as encompassing a finite temperature range in order to include enough data to produce a meaningful graph). Figures 4 through 7 also show the points from the references not used in the fit [1, 4, 6]; it can be seen that especially [4] and [6] deviate badly from the general trend of the data. Figure 5 (the 450 °C isotherm) also shows a few points from Baierlein [18], who did not report whether the phase coexisting with his salt-saturated vapor was liquid or solid. We have identified those points which (based on knowledge of the three-phase line) we believe to have been vapor-solid measurements. Those points are shown on figure 5 and listed in Appendix A. They were not used in the fit, but are in fair agreement with the data that were used.

There is substantial uncertainty in the solubility at low densities. While we chose to fit the points with lower solubilities partly based on the analysis of Shvedov [17] concerning hydrolysis, Galobardes et al. [2] claimed that hydrolysis was at most a moderate (on the order of 10-20 percent) effect at the conditions of their measurements. Since this issue is still not clearly resolved, and since several studies (at least one of which [11] measured sodium concentration which should not be affected by hydrolysis) report higher solubilities at these densities, we cannot rule out the possibility that the solubility of NaCl at low steam densities is significantly higher than that given by eq (4).

## 6. Silicon Dioxide

There is a great deal of measured solubility data for  $\text{SiO}_2$ , but unfortunately the vast majority is for geological conditions at pressures far beyond our range of interest (data in this category encountered in our literature search are, however, still listed in the bibliography and with the other solubility data in Appendix A). In the region of interest, there is a large amount of data from Heitmann [19], a moderate amount of data on two isotherms from Wendlandt [20], a few points from Morey and Hesselgesser [21, 22], and one point at a relatively high density from Kennedy [23]. Figure 8 shows the range of temperature and density covered by the  $\text{SiO}_2$  solubility data; only points included in the fit are shown in the figure.

A question with silicon dioxide is the form of the solid to be considered. In the temperature range of interest, quartz is the thermodynamically stable solid form. However, it is also easy to obtain an amorphous silica phase. Free-energy considerations indicate that the quartz phase should have a smaller solubility, so that the conservative approach would be to consider and correlate quartz's solubility. It might be, however, that nonthermodynamic factors would inhibit the precipitation of quartz so that the deposited phase would be amorphous silica. According to the data of Heitmann [19], quartz has a much lower solubility in water at liquid-like densities, but the two solubilities are about equal (the amorphous silica solubility still appears to be somewhat higher, but perhaps not within the experimental uncertainty) in low-density steam. We therefore

supplemented the quartz data with the portion of Heitmann's data for amorphous silica solubility taken in steam at relatively low pressures (50 kg/cm<sup>2</sup> and below). Each of these points was given 0.2 times the weight of the quartz points in the fit.

The two major data sources in the region of interest are Heitmann [19] and Wendlandt [20]. Unfortunately, these measurements disagree with each other significantly (though not as badly as the low-density NaCl data mentioned in the previous section). They are in fairly good agreement at higher densities, but at lower densities near 1 mol/L the solubilities of Wendlandt are lower by about a factor of 3 to 5. Examination of the dissertations containing the data [20, 24] did not reveal any obvious flaws. Both workers used a flow method to take their data, and both report examining the dependence of solubility on flowrate to ensure that equilibrium was reached. That examination appears to have been more extensive in Heitmann's work [24]; Wendlandt [20] only mentions that this flowrate independence was determined in previous experiments (which may not have even been on quartz, since several solutes are examined in his work). One might think of using the few points of Morey and Hesselgesser [21] in the region to decide between the two data sets. Unfortunately, the data from [21] are in closer agreement with Wendlandt's data on the 400 °C isotherm, but in closer agreement with Heitmann on the 500 °C isotherm. Ultimately, we decided to weight each of Wendlandt's points equally to each of Heitmann's quartz points. This had the effect of giving somewhat higher weight overall to Heitmann's data [19], since he reported more points.

Since our solubility estimates rely heavily on the data of Heitmann, we discuss them briefly here. Data for solubility of SiO<sub>2</sub> in water and steam were published in two places [19, 25], with the data in [25] a subset of that in [19]. The original source was Heitmann's dissertation [24]. This contains points at a few more conditions than were reported in the publications; we do not know whether there was a reason for omitting these points in the publications. To be safe, we did not include these extra points in our fit. What is more disturbing is the way Heitmann discarded some measurements. The dissertation reports all measured points, but marks with a cross those that were discarded. These points amounted to about 20 percent of all the measured points. The reason given by Heitmann for discarding these points was that they did not fit well on the solubility diagram he constructed (figure 1 in [19] and figure 7 in [25]). The discarded points are sometimes quite close to points that were not discarded; at other times they differ in solubility by about a factor of 2. We conclude that the reproducibility of Heitmann's measurements is probably not better than approximately a factor of 2. It is encouraging that his solubilities at higher densities where other data do exist are not too different from those measured by others.

We tested several forms; the data were ultimately fit to the equation

$$\ln(x_s) = A + DT + (m_1 + m_2\rho + m_3T)\ln\rho - \ln P, \quad (5)$$

with values of  $A = -21.6047$ ,  $D = 0.013\,558\,7$ ,  $m_1 = 1.055\,55$ ,  $m_2 = 0.094\,100\,5$ , and  $m_3 = 0.000\,912\,888$ . Figures 9 and 10 show the deviations of experimental values of  $\ln(x_s)$  from eq (5) as a function of density and temperature. Figures 11 and 12 show comparisons of the experimental data and eq (5) for the 400 °C and 500 °C isotherms.



## 7. Sodium Phosphate

The situation for  $\text{Na}_3\text{PO}_4$  is complicated by the chemistry. The Na/P ratio in aqueous solution can vary over a wide range. The solids in equilibrium can have various compositions, and under some circumstances a second liquid phase can form. Some of this chemistry is summarized by Marshall [26] and by Wetton [27]. However, it appears that one can, at least approximately, focus on a 3:1 Na/P ratio and ignore most of the chemistry, since the equilibrium solid from that ratio has a Na/P ratio near 2.8 [27]. This allows us to make rough solubility estimates based on earlier data for  $\text{Na}_3\text{PO}_4$  which did not take the extra chemistry into account. One would hope that the complex chemistry would be less important in the steam phase.

Unfortunately, we could find no data for  $\text{Na}_3\text{PO}_4$  solubility in steam. We therefore used an indirect estimation method. First, the measured solubility in liquid water at saturation at a high temperature was combined with vapor-liquid partitioning data to estimate the solubility in the saturated vapor at that temperature. Then we extrapolated from that point by assuming that the dependence of the solubility on temperature and density was the same as for a model solute.

The highest temperature at which there are measurements for liquid-phase solubility is 350 °C. The mole-fraction solubility at that temperature is  $1.65 \times 10^{-4}$  according to Schroeder et al. [28] and  $5.97 \times 10^{-4}$  according to Wetton [27]. We decided to give more weight to the more recent study [27], since the complex chemistry was not appreciated at the time of the Schroeder et al. [28] work. We therefore used a value of  $5.0 \times 10^{-4}$ .

For the distribution between vapor and liquid, we used the data of Goodstine [29, supplemented by additional data courtesy of ABB Combustion Engineering], who measured the partitioning of sodium between vapor and liquid phases at various concentrations and pressures. The data we used were graphs of sodium concentration (in parts per million) in coexisting vapor and liquid phases. Values read from the graph, conversion of those data to mole fractions, and derived partition coefficients are given in tabular form in Appendix C, which also gives the results of similar calculations with  $\text{Na}_2\text{SO}_4$ . The pressures were translated to temperatures by using vapor pressures of pure water from the Steam tables [3], which should not introduce much error since the solute concentrations were low. Since none of Goodstine's measurements was at solid saturation, the partition coefficients (which were concentration-dependent) had to be extrapolated to saturation. In this extrapolation, we made the conservative assumption that the partition coefficient leveled off as saturation was approached. Based on the extrapolated values of the partition coefficient at saturation at various temperatures, we estimated a partition coefficient of  $5.6 \times 10^{-4}$  at saturation at 350 °C, which gives a vapor mole fraction of  $2.8 \times 10^{-7}$ .

To get an equation for the solubility of sodium phosphate at any condition, we then assume that its change in solubility with density and temperature is the same as for some model substance. We choose sodium chloride as the model substance since it has the most data in the region of interest. We use the NaCl equation to extrapolate from the saturated vapor at 350 °C, where the density of pure water is 6.3061 mol/L. The equation is therefore:

$$x_s = 2.8 \times 10^{-7} \frac{x_{\text{NaCl}}(T, \rho)}{x_{\text{NaCl}}(350^\circ\text{C}, 6.3061 \text{ mol / L})} \quad (6)$$



The uncertainty introduced by this extrapolation to the region of interest is probably at least two orders of magnitude; this is discussed more fully in a subsequent section.

It is important to reiterate that, in addition to uncertainty introduced by the extrapolation above, the poorly understood chemistry of aqueous sodium phosphate at high temperatures adds a great deal of uncertainty to these estimates. Anyone using eq (6) to estimate sodium phosphate solubility in superheated steam must recognize that the total uncertainty is probably several orders of magnitude.

## 8. Sodium Sulfate

The data situation for  $\text{Na}_2\text{SO}_4$  at the conditions of interest is not good. Figure 13 shows the range of temperature and density covered by the data. There are a number of data points from Sastry [11] along a single isotherm at 402 °C. There are some data from the Russian literature [8, 10] reporting solubilities about an order of magnitude below Sastry in the range where they overlap. At higher temperatures, the Russian data are unusual in that they display a decrease (or at least no increase) in solubility with increasing steam density. Two points from Morey and Hesselgesser [22] at 500 °C fall two or three orders of magnitude above the Russian data. Finally, there is a single tentative datum at 500 °C from Armellini and Tester [5], who reported major difficulties in trying to establish a reproducible solubility measurement. This point is about an order of magnitude above the Russian data. Additional data on the three-phase line from the Russian thesis of Novikov [30] have a small amount of overlap with the data of Styrikovich [10]. At temperatures around 600 K, Novikov [30] gives solubilities about two orders of magnitude below those implied by Styrikovich [10]. Near 640 K, however (the highest temperature of his data), Novikov [30] seems to be approximately consistent with Styrikovich [10]. We consider the results of [30] to be questionable at the lower end of the reported temperature range, because the reported vapor concentrations at temperatures below about 600 K are so small that it is unlikely they could have been directly measured experimentally. We cannot tell from the material available to us whether some (or perhaps even all) of these vapor concentrations were somehow estimated rather than measured, but it seems that some of them must have been.

We can get an additional estimate of steam solubility of  $\text{Na}_2\text{SO}_4$  at saturation by using the solubility in the liquid and the vapor-liquid distribution data of Goodstine [29], just as was done for sodium phosphate. Unfortunately, there is some discrepancy in the liquid solubility measurements at high temperatures. The data of Ravich and Borovaya [31], Schroeder et al. [32], and Booth and Bidwell [33] are all in fair agreement, but the solubilities of Khaibullin and Novikov [34, 35] are lower by a factor of 2 or 3. We decided to accept the majority of the investigations and to begin with the saturated-liquid solubility of  $2.8 \times 10^{-3}$  at 360 °C as measured by Booth and Bidwell [33]. Interpolation of the data of Goodstine [29, supplemented by additional data courtesy of ABB Combustion Engineering] produces a vapor-liquid distribution ratio at those conditions of  $5.3 \times 10^{-4}$ , leading to a solubility in the saturated vapor at 360 °C (where, for future reference, we note that the steam density is 7.9876 mol/L) of  $1.5 \times 10^{-6}$ . This number seems to be in fair agreement with extrapolations of the steam solubilities reported by Sastry [11] and by Armellini and Tester [5]; it is clearly higher than indicated by the Russian data [8, 10, 30] and lower than indicated by the data of Morey and Hesselgesser [22].

We therefore accept this point and assume a density and temperature dependence identical to that for sodium chloride. Using the equation for sodium chloride, we then have:

$$x_s = 1.5 \times 10^{-6} \frac{x_{\text{NaCl}}(T, \rho)}{x_{\text{NaCl}}(360^\circ\text{C}, 7.9876 \text{ mol / L})}. \quad (7)$$

This procedure can be tested by seeing how well eq (7) agrees with the sparse and scattered data for sodium sulfate solubility (only densities below 10 mol/L are considered here). Figures 14 and 15 show the deviations of the data from eq (7) as a function of density and temperature. We see large deviations in both directions, indicative of the scatter in the data. The largest errors are at low temperatures and densities from Novikov [30], where the equation gives solubilities several orders of magnitude higher than the data. As already mentioned, we have reason to question these measurements; it also seems unlikely that the solubilities would deviate that drastically from the much better-established values for the solubilities of NaCl on the vapor side of the three-phase line. The other Russian data [8, 10] give higher solubilities than eq (7) at low densities but lower at high densities; we have already mentioned that the density dependence of these solubility data seems physically unrealistic. The solubilities of Morey and Hesselgesser [22] are also far above that given by eq (7), but they disagree as severely with the measurements of others in the region where they overlap. Figures 16 and 17 show two approximate isotherms where eq (7) is compared to the solubility data. The equation is at least in the neighborhood of data from [5], [8], [10], and [11]. The density dependence of [8] and [10] is not reproduced, but, as mentioned above, we suspect the density dependence reported in those papers may be unphysical.

After this project was completed, we learned of the work of Pritchard et al. [36]. While they did not report their original data, they gave an equation (as a function of density only, which is physically unrealistic) correlating their solubility measurements in the range 623 to 773 K and 4 to 17 MPa. Their solubilities are lower than those reported by others in the same region, and are lower than and have a weaker density dependence than eq (7). Figures 16 and 17 also show the values given by [36]. This additional discrepant data, along with their observation of hydrolysis, reinforces our point that the solubility of sodium sulfate in steam is poorly understood.

In summary, eq (7) is probably the best we can do for sodium sulfate given the uncertain state of the data. It roughly agrees with the scattered measurements to within one or two orders of magnitude, with the exception of some data that we have reason to suspect. We also note that the measurement difficulties and inconsistencies could be an indication that hydrolysis (known to occur at these conditions) or other chemistry is playing a major role; for example, the bisulfate might be a significant or even dominant species in some of the experiments. These complications are beyond the scope of this study, but would add even more uncertainty to the results. The potential importance of sodium sulfate in steam power systems is such that further experimental work on this system could be very useful to industry.



## 9. Copper Oxides

There are very few data concerning the solubility of copper oxides in steam. Figure 18 shows the range of temperature and density covered by the data in the region of interest. The solubility of CuO in steam has been measured by Pocock and Stewart [37] and by Hearn et al. [38]. Unfortunately, in the regions where the studies overlap, the solubilities reported by Hearn et al. are higher by more than an order of magnitude. Hearn et al. point to three factors which might cause the results of Pocock and Stewart to be systematically low: (1) there was corrosion of Pocock and Stewart's stainless steel apparatus, as evidenced by their observation of hydrogen generation, which might lead to contamination with iron-copper complexes; (2) the experimental configuration might not have allowed all of the steam to equilibrate with the solute; and (3) Hearn et al. observed that, in one modification of their own apparatus that used some stainless steel components, copper metal plated out on the stainless steel, perhaps by some electrochemical displacement reaction, giving low solubilities. Since Pocock and Stewart used a stainless steel apparatus, it is likely that this problem occurred in their experiments.

We therefore begin by fitting the data of Hearn et al. [38]. The small amount of data at low densities suggests a strategy of picking one point as a base and using the NaCl equation to predict other values. When this is done, the temperature dependence of the data is reproduced fairly well, but the density dependence seems to be far off. We therefore refit eq (4) to the data (specifically, just to those points at densities below 10 mol/L), keeping the temperature dependence determined for NaCl but allowing the other parameters to vary. This resulted in the equation

$$\ln(x_s) = A + B/T + (m_1 + m_3/T)\ln \rho - \ln P, \quad (8)$$

with values of  $A = -9.75084$ ,  $B = -4852.47$ ,  $m_1 = 1.14584$ , and  $m_3 = -0.0013$ . The units are the same as for eq (4); note also that the  $B$  and  $m_3$  parameters are unchanged. Figures 19 and 20 show the deviations of the data from eq (8) as a function of density and temperature. The Hearn [38] data (including those at densities above 10 mol/L where eq (8) is an extrapolation) are fitted very well. The extrapolation of eq (8) also is in fair agreement with two data points at higher density from Var'yash [39]; these data are discussed further below.

However, for making a conservative estimate, eq (8) may not be sufficient. Even though we have reason to believe there are problems with the data of Pocock and Stewart [37], the Hearn et al. data are not necessarily correct. In particular, the density dependence raises a question. The data of Hearn et al. [38] showed a much weaker decrease in solubility with decreasing density than the NaCl data, as reflected in the need to refit the density dependence in the fitting equation. The data of Pocock and Stewart, which may be systematically low, show a somewhat faster decrease in solubility (though still not as fast as NaCl). We cannot rule out the possibility that the solubility may decrease somewhat faster with decreasing density than would be indicated by extrapolating eq (8). For the low (near 0.5 mol/L) densities of most interest in this work, this could result in overprediction of the solubility by one or two orders of magnitude.

In order to provide what might be a lower bound on the solubility, we also fit the Pocock and Stewart [37] data. Again, the temperature dependence from eq (4) was kept, so only the constant term and density dependence were adjusted to the data. The resulting equation is

$$\ln(x_s) = A + B / T + (m_1 + m_3 / T) \ln \rho - \ln P, \quad (9)$$

with values of  $A = -14.9399$ ,  $B = -4852.47$ ,  $m_1 = 2.59618$ , and  $m_3 = -0.0013$ . The units are the same as for eq (4); again the  $B$  and  $m_3$  parameters are unchanged. Figures 21 and 22 show the deviations of the data from eq (9) as functions of density and temperature.

Unfortunately, when extrapolated to the low densities of interest in this study, eqs (8) and (9) differ by about two or three orders of magnitude (this can be seen in the sample calculations in Appendix E). This is due both to the higher solubility of the Hearn [38] data in the region where the two studies overlap, and to the larger density dependence of the solubility in the Pocock and Stewart [37] study. It is, of course, possible that the truth lies somewhere between the two data sets; for example, the Hearn data might be of the correct magnitude but the true density dependence might be that of Pocock and Stewart. It seems plausible that, in the low-density region of interest, we can consider eqs (8) and (9) to be approximate upper and lower bounds, respectively, on the solubility of CuO.

It is worth examining the limited CuO solubility data at higher densities of Var'yash [39] to see if they can offer any insight into the relative merits of the other two data sets. Palmer et al. [40] recently pointed out that, when a fit they had done to the Pocock and Stewart [37] data was extrapolated to the condition of saturated liquid water at 350 °C, it came close to matching the solubility at those conditions reported by Var'yash. However, the highest water density in the data of Pocock and Stewart [37] is about 7.3 mol/L (compared to almost 32 mol/L for the saturated liquid data point from [39]), and the lowest temperature in [37] is about 476 °C. This makes the extrapolation in both density and temperature so large that, while its results are interesting and somewhat suggestive, it cannot be given much weight as evidence for the validity of the low-density data of Pocock and Stewart [37]. This is underscored by the fact that (as seen in figures 19 and 20) our extrapolation of the Hearn [38] data as fit by eq (8) is also in reasonable agreement with this datum.

We feel that a better comparison for our purposes can be made with the point reported by Var'yash [39] at 450 °C and 50 MPa. This is within the temperature range of [38], and just below that of [37]. The density is still too high (about 22.3 mol/L), but not as much so as the 350 °C saturated liquid data point. Unfortunately, this point also does not help distinguish between the two data sets, because of their different density dependence. While the solubilities of Pocock and Stewart [37] are lower than those of Hearn et al. [38] at the densities where the studies overlap, they increase more quickly with density. As a result, when extrapolated, they both produce values that are in reasonable agreement with this data point of Var'yash [39]. The extrapolation of [38] comes closer to the datum, but the difference is not significant in light of the uncertainties in the data. Figure 23 shows an isotherm for CuO at temperatures near 740 K, showing the behavior of eqs (8) and (9) at lower densities than those where data exist and also at the higher density of the steam solubility data point of Var'yash [39]. This figure shows the



irreconcilable differences between the two data sets, the worsening of that difference at low density, and also the fact that the higher-density data from Var'yash [39] does not help us distinguish between the two sets.

The only  $\text{Cu}_2\text{O}$  data are from Pocock and Stewart [37], and if the critique of their  $\text{CuO}$  data by Hearn et al. [38] is correct these data would probably also be systematically low. The data are all at essentially one temperature (about 893 K) and cover a relatively narrow range of densities. If we accept the Pocock and Stewart data, it is reasonable to once again take the temperature dependence from the  $\text{NaCl}$  equation and adjust only the constant term and the density dependence to the data. The result is

$$\ln(x_s) = A + B / T + (m_1 + m_3 / T) \ln \rho - \ln P, \quad (10)$$

with values of  $A = -21.4219$ ,  $B = -4852.47$ ,  $m_1 = 6.272\,27$ , and  $m_3 = -0.0013$ . Figure 24 shows the fit of eq (10) to the data of Pocock and Stewart [37]. The density dependence is steeper than that of the Pocock and Stewart [37]  $\text{CuO}$  data, and much steeper than for the Hearn [38]  $\text{CuO}$  data. If the density dependence were, for example, really that of Hearn's  $\text{CuO}$  data, eq (10) would underestimate the solubility at low-density conditions by several orders of magnitude. If the Pocock and Stewart [37] data have the same systematic problems that may have affected their  $\text{CuO}$  solubility data, then eq (10) would underestimate the solubility.

Finally, there may be uncertainties due to the chemistry for the copper oxides. Turbine deposits are sometimes copper metal and sometimes either or both of the two oxides [37]. This suggests that some electrochemical oxidation/reduction processes are taking place in the high-temperature water and/or steam. Such chemical processes would add a great deal of uncertainty to any estimates based on equilibrium solubility of individual oxidation states, and would also render suspect the solubility measurements themselves. Electrochemical transport mechanisms may well be very important for copper in steam, but they are beyond the scope of this study.

## 10. Sodium Hydroxide

It is more difficult to assess and model the solubility of sodium hydroxide because the equilibrium at conditions of interest would not be with a pure solid but rather with a  $\text{NaOH}$ -rich liquid. The few sources of data in the region of interest [11, 13, 14] all indicate that the equilibrium solubility of  $\text{NaOH}$  in low-density steam is approximately the same (within about a factor of 2, which is at least as good as the data) as that of  $\text{NaCl}$ . We therefore consider it appropriate to apply the equation developed for  $\text{NaCl}$  also to  $\text{NaOH}$ .

## 11. Iron Oxides

There is a fair amount of data for the solubility of iron oxides in liquid water at high temperatures [41-49]. The tiny solubility in liquid water is heavily influenced by the chemistry; many studies used hydrogen to maintain a reducing environment and some reported variations in solubility with pH. In steam, the electrochemical solubility reactions would be more unfavorable. All indications are that the equilibrium solubility of iron oxides in neutral steam would be



exceedingly small. We therefore did not consider iron oxides further on the grounds that the equilibrium transport in steam would be negligible and the only potential problem would be mechanical carryover, which is beyond the scope of this study.

## 12. Assessment of Extrapolation

Some assessment needs to be made with regard to the validity of using NaCl as a model substance for extrapolating limited solubility data for other substances. There are two different sources of error in this extrapolation procedure: (1) uncertainty in the behavior of NaCl itself, as evidenced by the data discrepancies mentioned above; and (2) the likelihood that the density and temperature dependence of the solubility of the other substance will not match that of NaCl.

In order to get some idea of the second uncertainty, we examined the extrapolation behavior of both the NaCl equation (4) and the SiO<sub>2</sub> equation (5) from a starting point of 350 °C and 6.306 mol/L, which was the starting point for the sodium phosphate extrapolation. The complete results are given in Appendix D. Here we mention the extrapolation to two points of interest. For an approximate “entrance” condition (where “entrance” and “exit” refer to conditions encountered in the channels of the Advanced Turbine System) of 300 °C and 1 mol/L, the ratio of the solubility at that state to that at the starting point was  $5.016 \times 10^{-4}$  for the NaCl equation and  $8.548 \times 10^{-3}$  for the SiO<sub>2</sub> equation. For an “exit” condition of 600 °C and 0.5 mol/L, the ratios were  $4.796 \times 10^{-4}$  for the NaCl equation and  $1.338 \times 10^{-1}$  for the SiO<sub>2</sub> equation.

From these sample calculations, we conclude that these extrapolation methods introduce a large uncertainty, particularly at lower densities. There can be two orders of magnitude difference between the NaCl and SiO<sub>2</sub> equations. It is logical that different substances would behave somewhat differently as a function of temperature and density. If we view the solubility as a “hydration” reaction, the details of that reaction (such as the number of water molecules involved in the hydration) are potentially quite different depending on the nature of the solute. In general, there seems to be no way to predict the differences between solutes.

Therefore, while the lack of data leaves us with no other choice but to use this kind of extrapolation technique, we must recognize that the extrapolation is highly uncertain and should not be trusted within less than about two orders of magnitude, especially at low densities.

## 13. Summary of Solubility Calculations

For checking the implementation of the equations given in this paper, tables of calculated solubilities as a function of temperature and pressure (from 200 to 900 °C and 1 to 6 MPa) are given in Appendix E. The number of digits given in these tables is only for the purpose of checking calculations and is not indicative of the accuracy of the formulations. Appendix E also lists the equation (and its coefficients) used to generate each table. In these calculations, density was determined from a given temperature and pressure from the Steam Tables [3]. Some of the points at 200 °C are not given because they would produce liquid densities, which are far outside the range of these correlations. In many cases, other points in the table will also be extrapolations

far beyond the range in which the correlation should be used. Consult the sections on the individual solutes for comments on the level of confidence to place in these computations.

#### 14. Need for New Data

The literature search on which this report is based was as thorough as possible. Essentially all the data on the compounds of interest in the region of interest were examined. Only for sodium chloride and silicon dioxide were there enough data for fairly definitive estimates of their solubilities in steam, and even for those solutes there were discrepancies between data sources at low steam densities. We must therefore conclude that, for most other common steam impurities, there are insufficient data for definitive engineering of steam cooling systems for combustion turbines. Steam purity recommendations are based on preventing deposition of impurities. Iron oxide can be controlled by feedwater chemistry. Copper oxides can be controlled by eliminating copper alloys from the system. Control of salts is more difficult. Both sodium phosphate and sodium sulfate can be expected to form low-melting deposits on the surface of the nickel alloys typically used in combustion turbines. These low-melting deposits can be expected to lead to hot corrosion. Margins can be added to the solubilities estimated in this report to provide conservative estimates of solubilities. Water can be made adequately pure to maintain the concentrations of the various compounds below conservative values. However, the cost of purifying water is not inconsequential, and the cost increases as the tolerable impurity concentration decreases. Therefore, good quality data for the solubility of sodium phosphate and sodium sulfate in steam would be economically beneficial. For those solutes where the solubility is complicated by hydrolysis or other reactions, better understanding of those reactions would also be beneficial.

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## 15. Bibliography

References are listed in the order in which they are cited. Some data references were collected and tabulated without being mentioned in the main body of the report; these (beginning with reference [50]) are listed in the order they appear in Appendix A. Finally, some additional papers were collected which were of less direct relevance to this work (for example, papers summarizing or correlating data reported elsewhere). These papers (beginning with reference [64]) are listed chronologically at the end of this bibliography.

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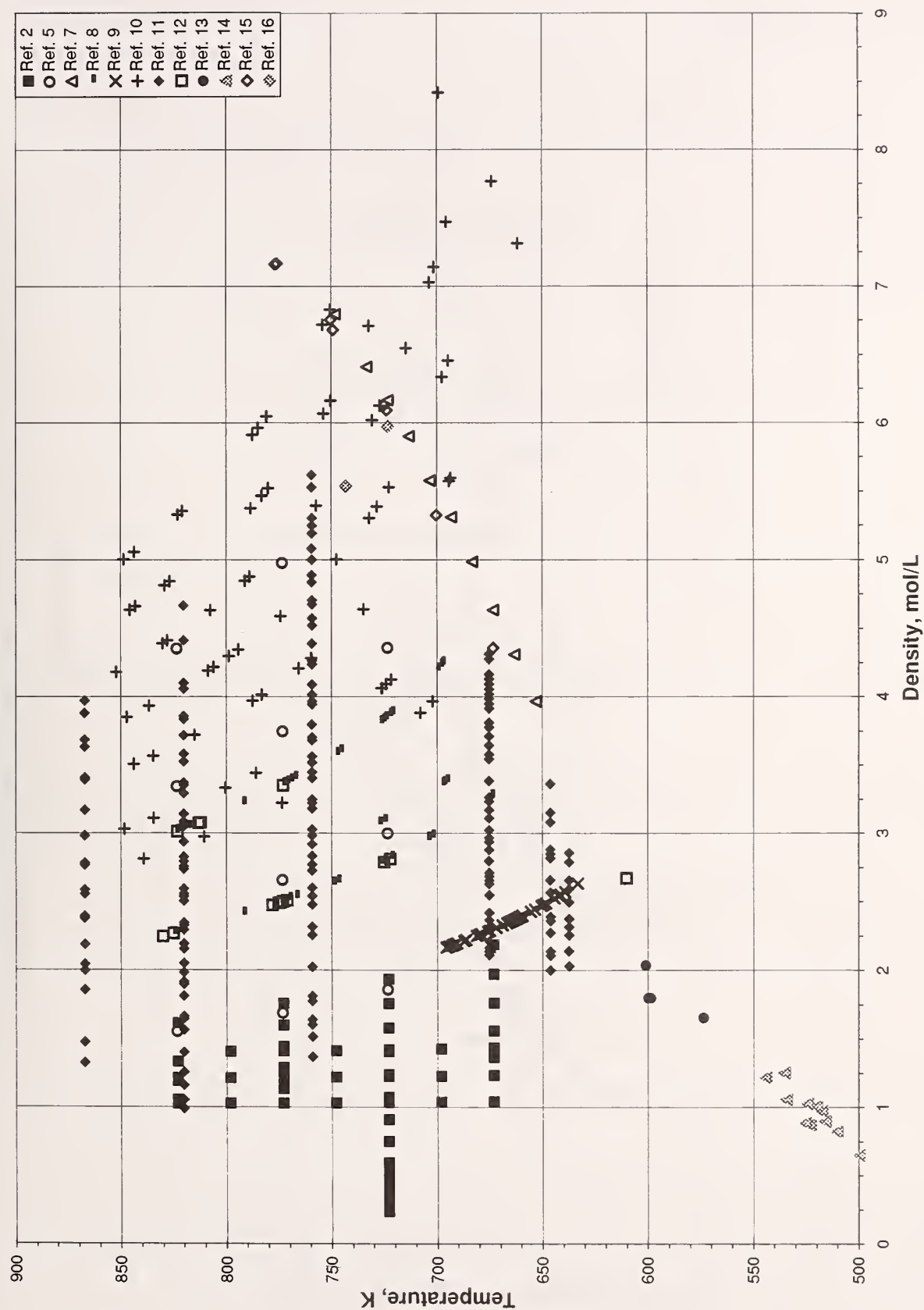


Figure 1. NaCl data points used in equation fit.



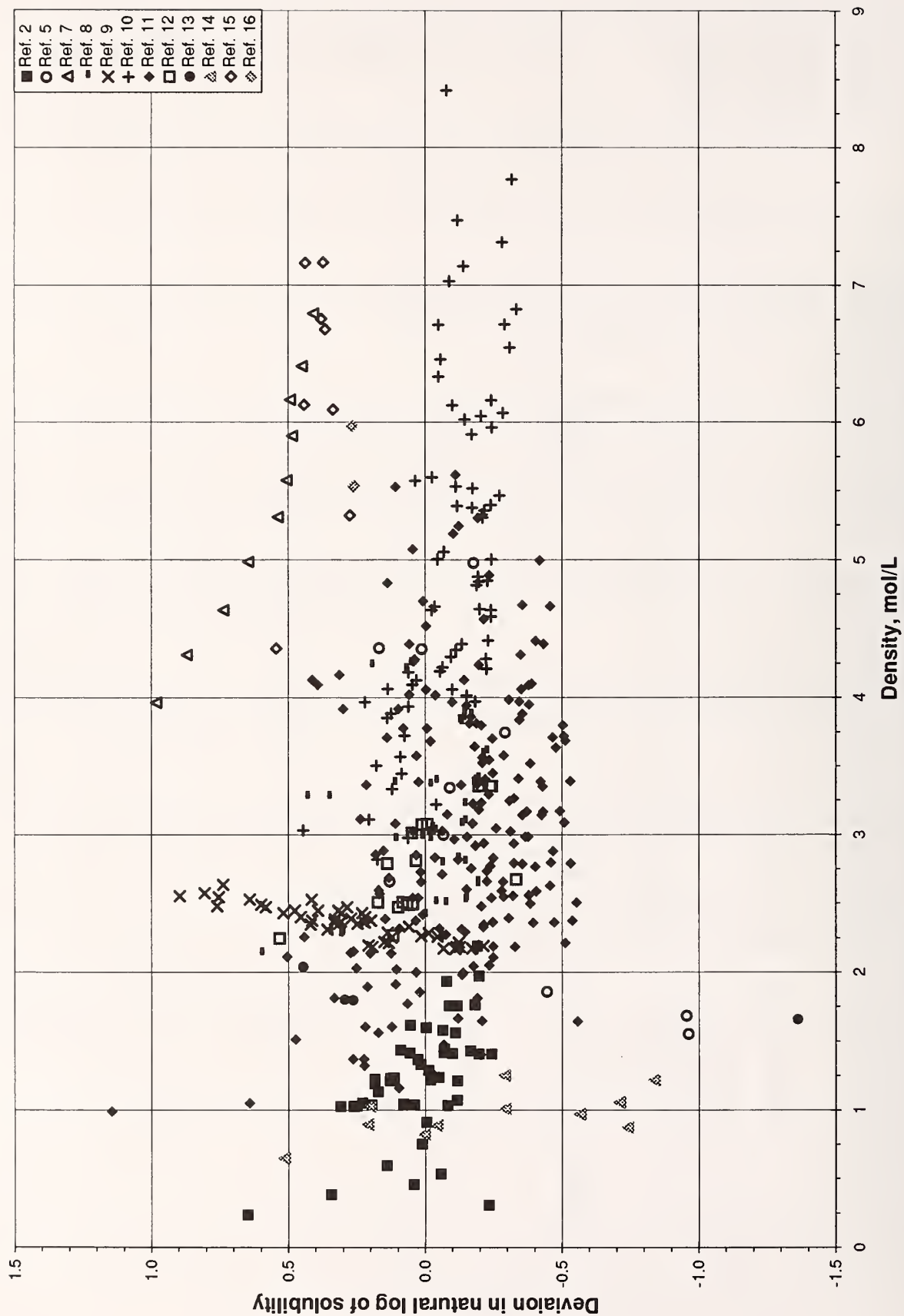


Figure 2. Deviation of data from solubility equation for NaCl.



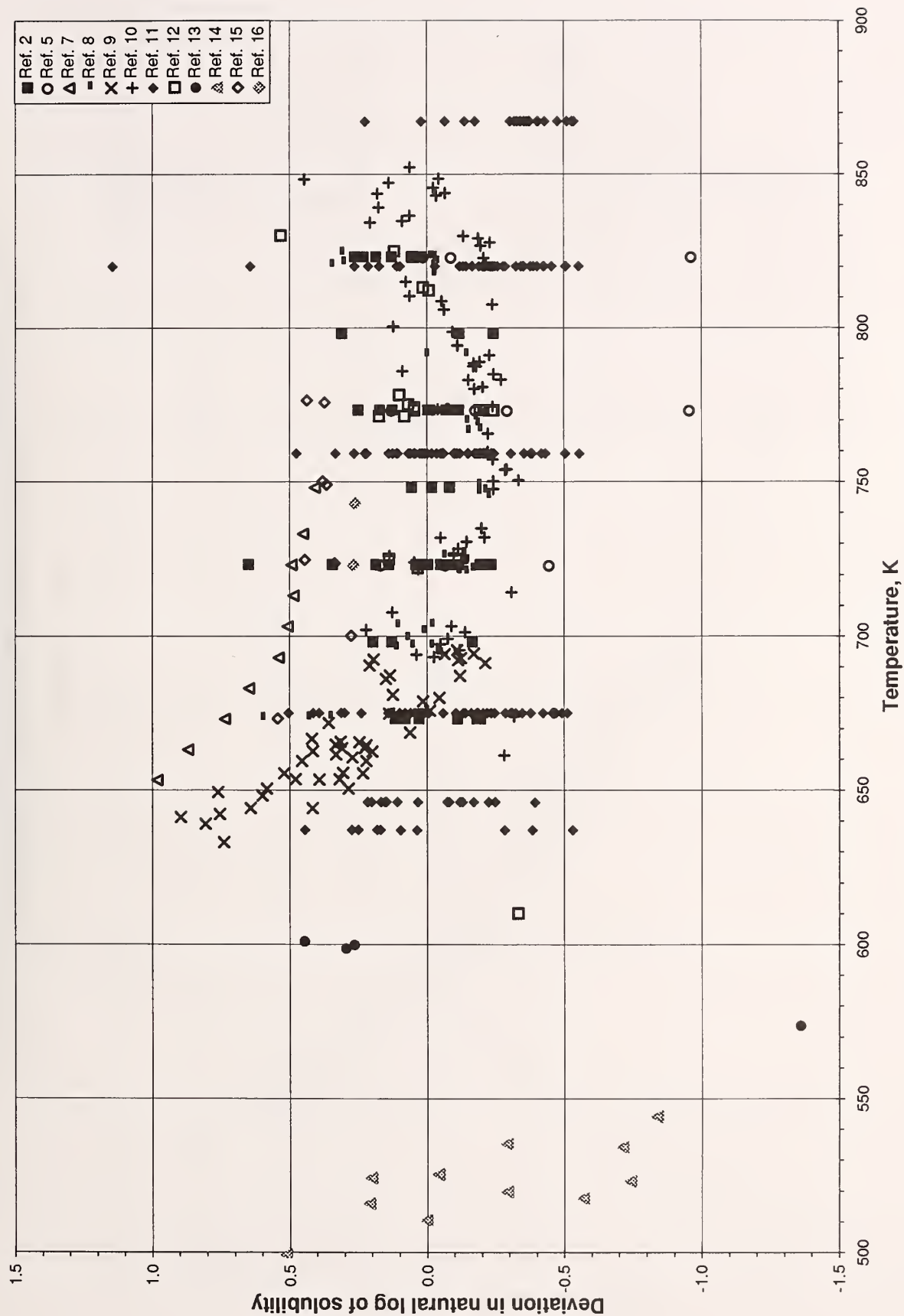


Figure 3. Deviation of data from solubility equation for NaCl.

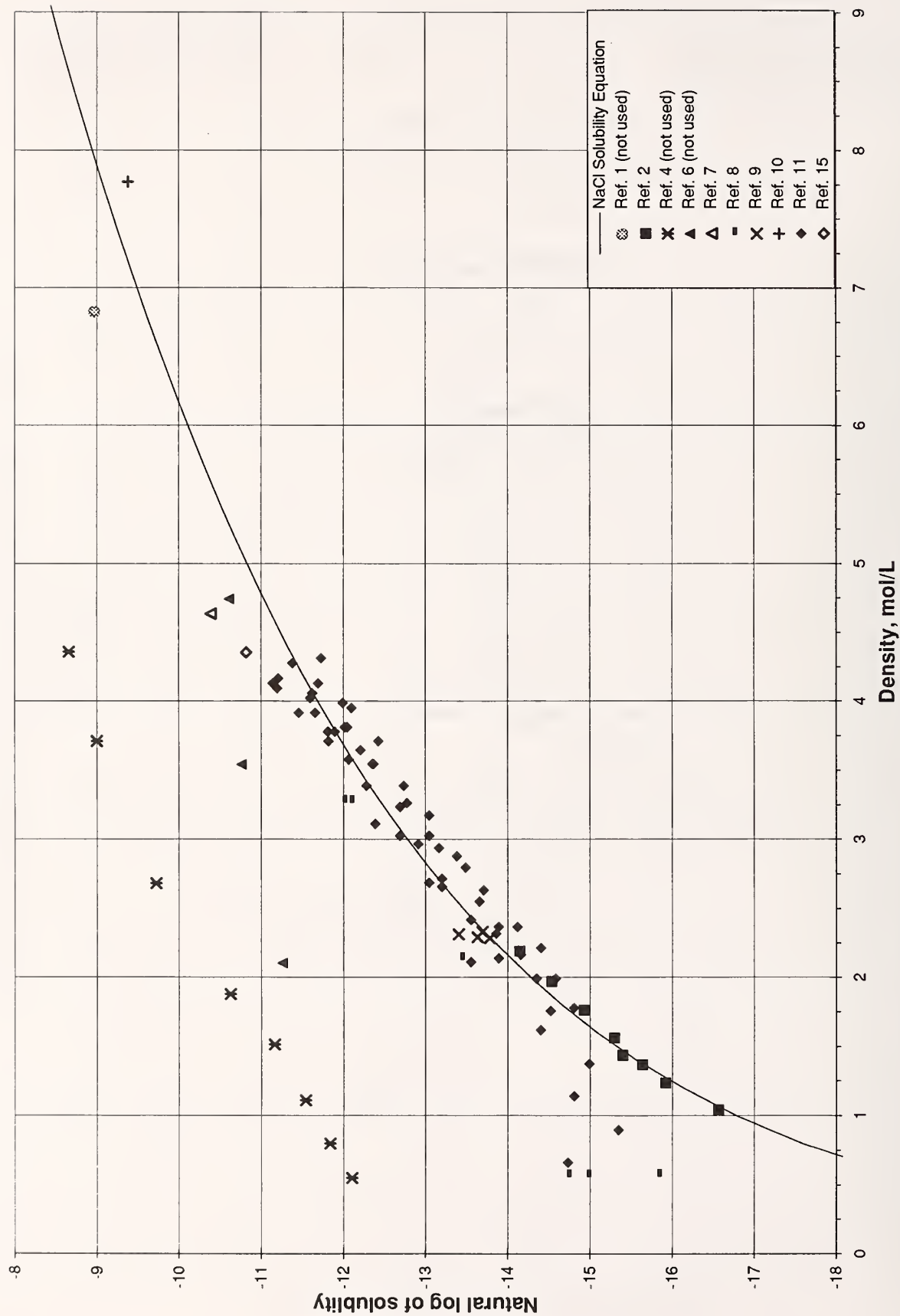


Figure 4. Calculated and experimental solubilities for NaCl at 400 °C ± 5 °C.

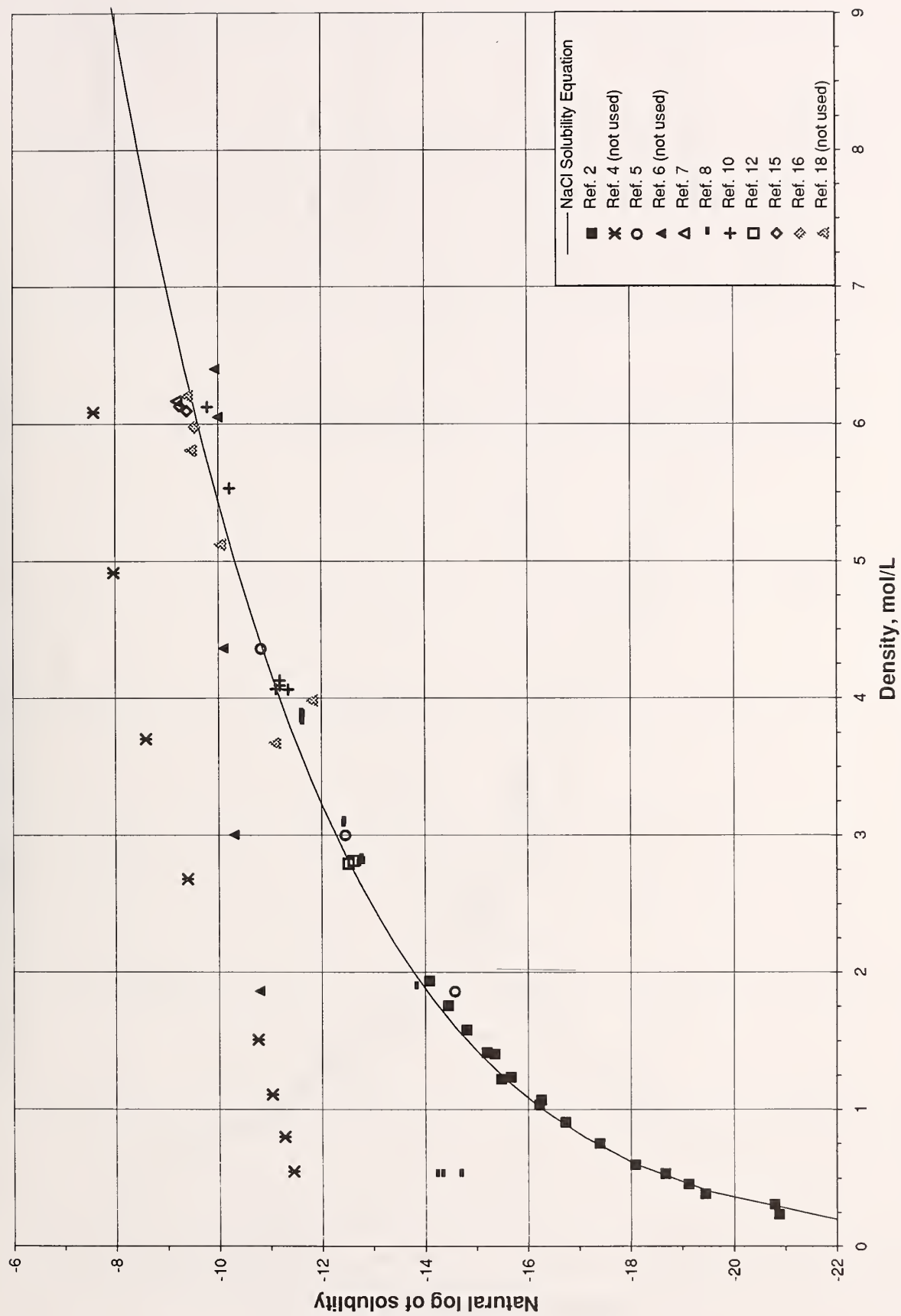


Figure 5. Calculated and experimental solubilities for NaCl at 450 °C ± 5 °C.



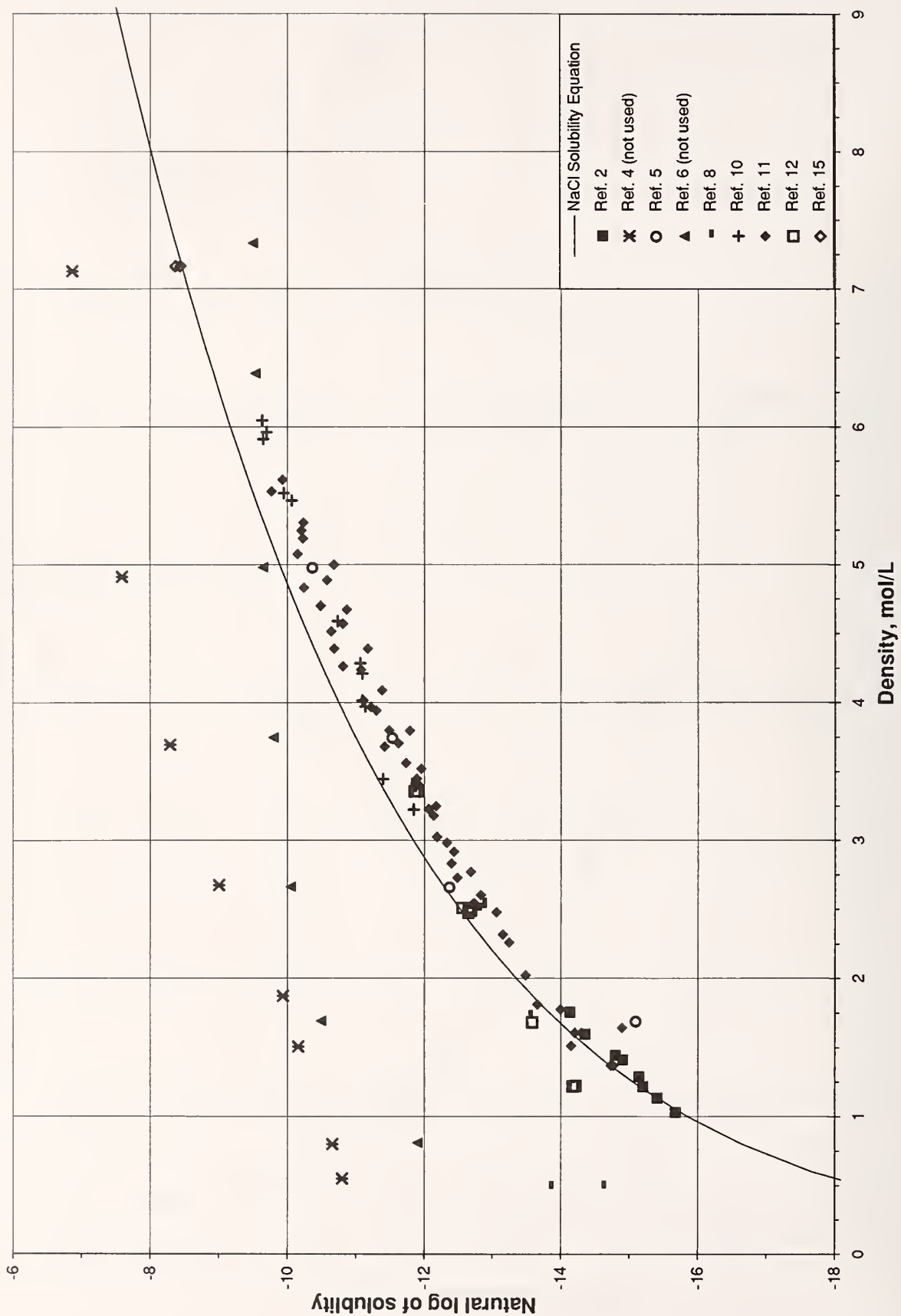


Figure 6. Calculated and experimental solubilities for NaCl at 500 °C ± 5 °C.

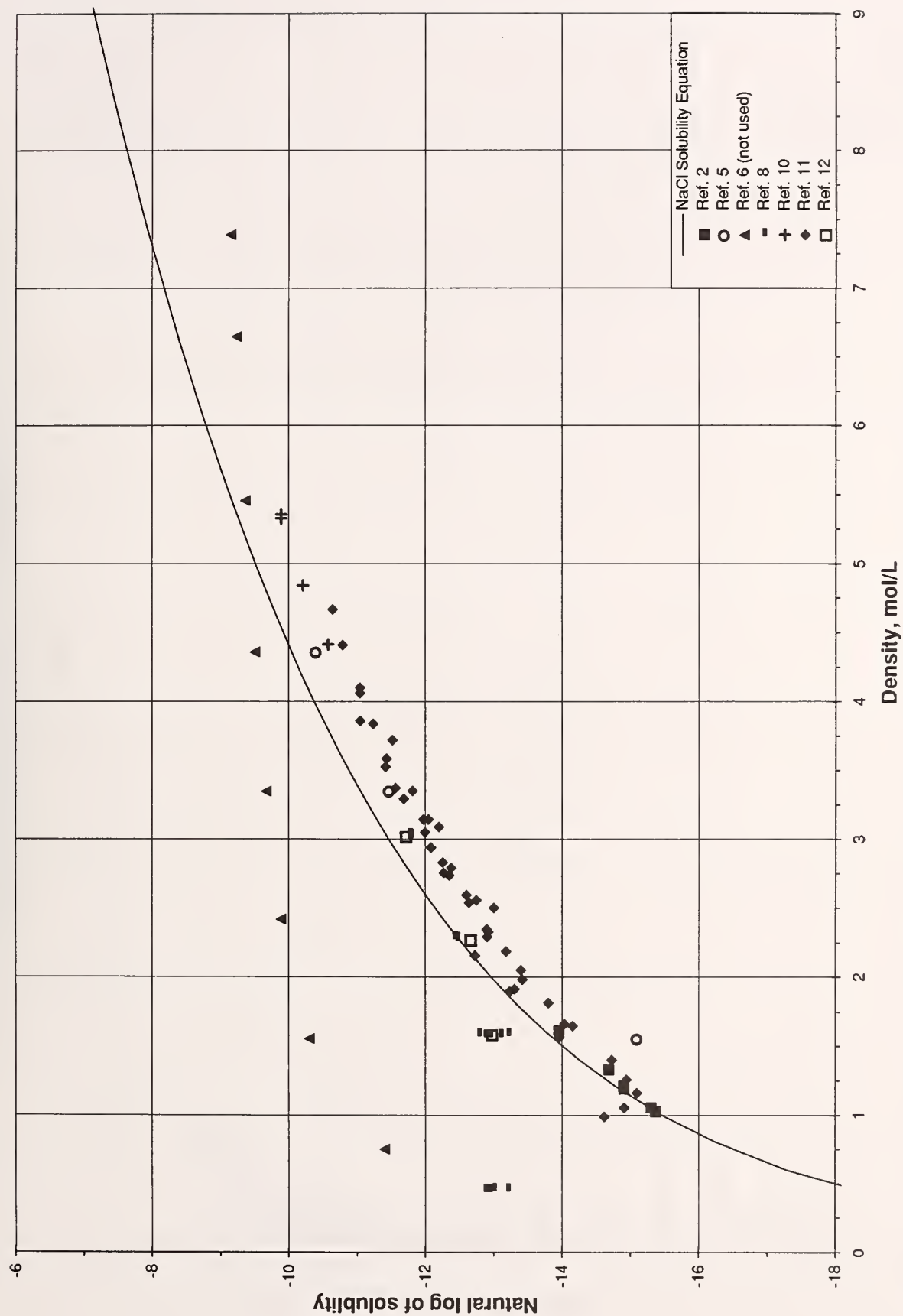


Figure 7. Calculated and experimental solubilities for NaCl at 550 °C  $\pm$  5 °C.

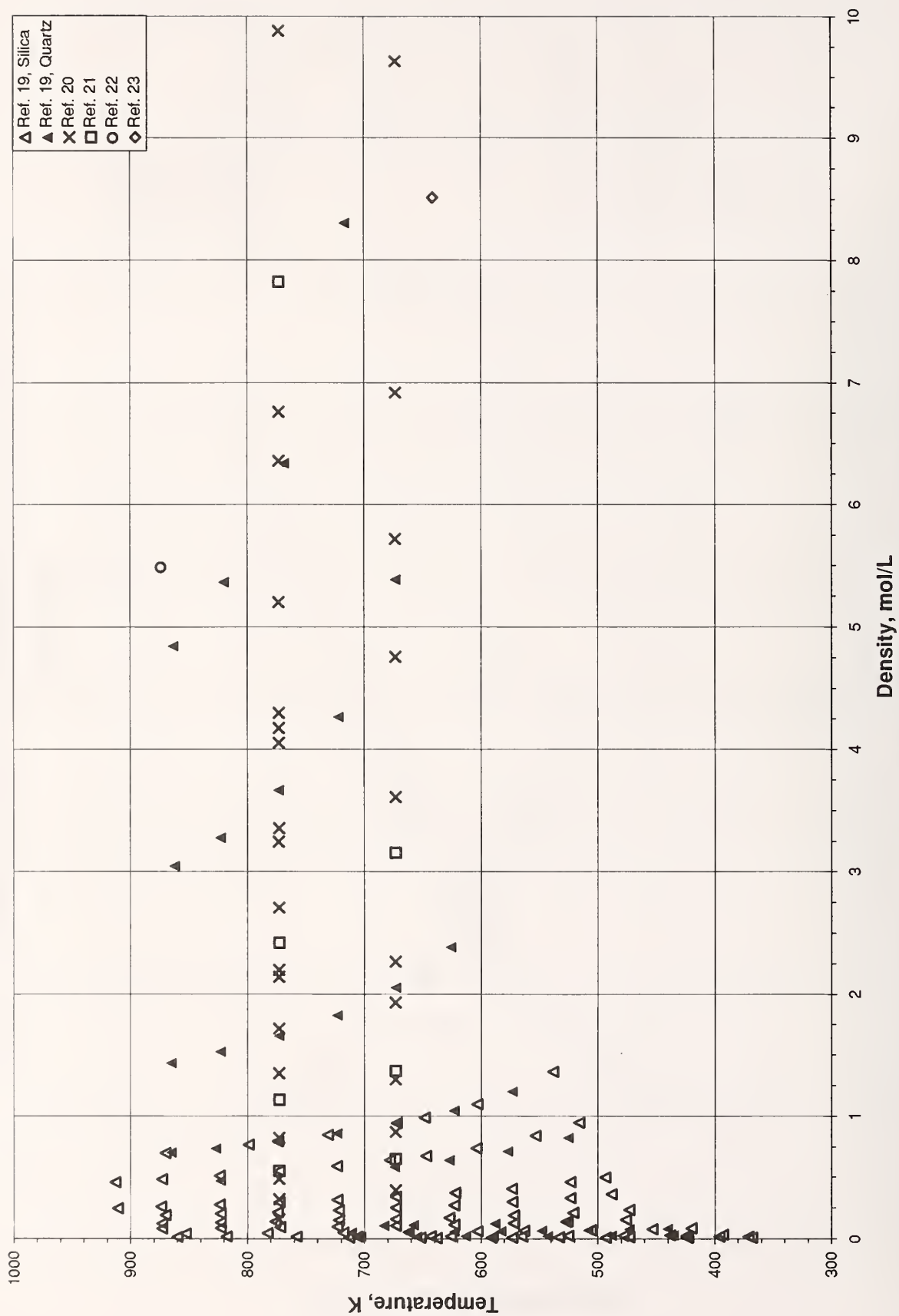


Figure 8. SiO<sub>2</sub> data points used in equation fit.



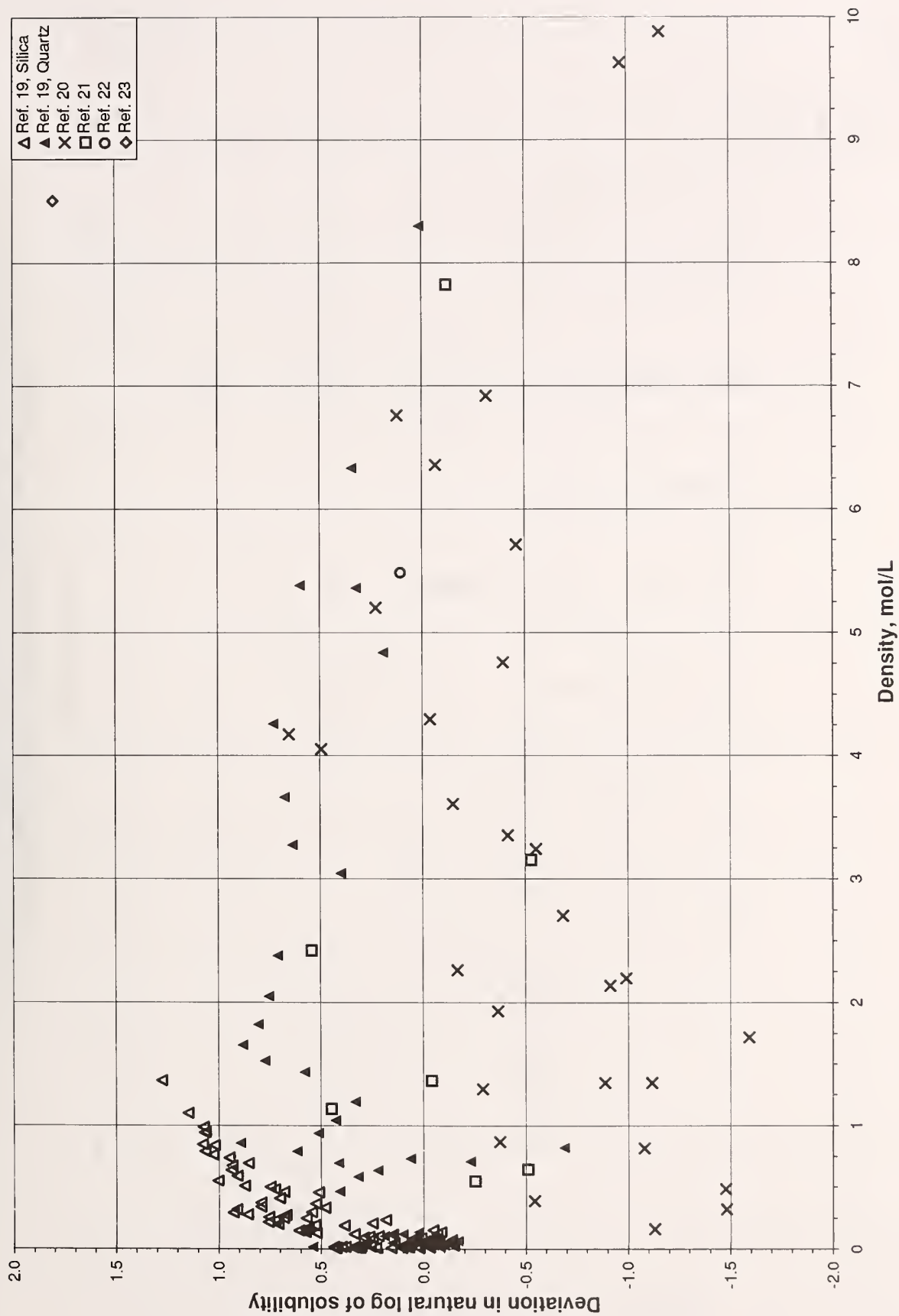


Figure 9. Deviation of data from solubility equation for  $\text{SiO}_2$ .

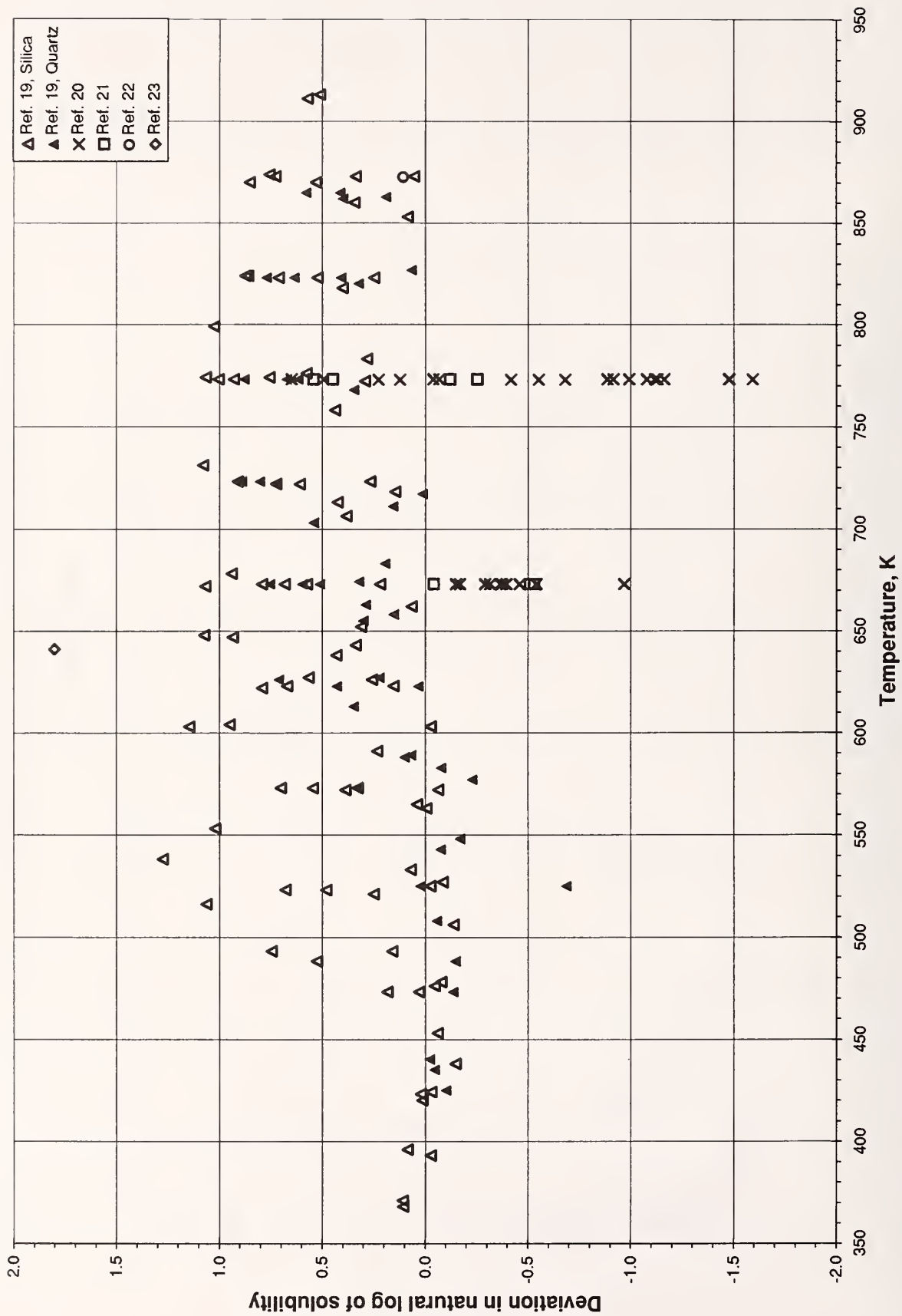


Figure 10. Deviation of data from solubility equation for  $\text{SiO}_2$ .

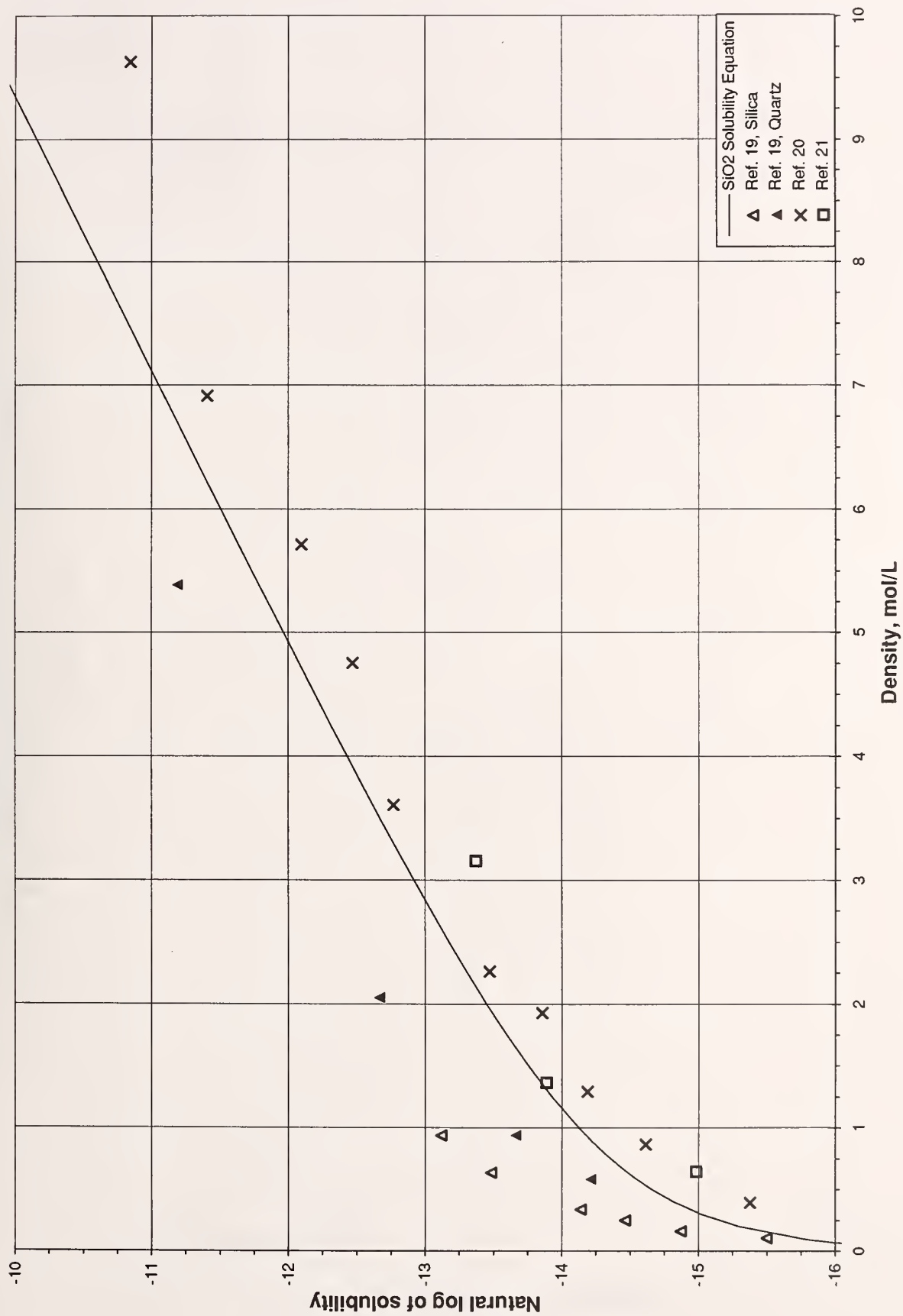


Figure 11. Calculated and experimental solubilities for  $\text{SiO}_2$  at  $400\text{ }^\circ\text{C} \pm 10\text{ }^\circ\text{C}$ .



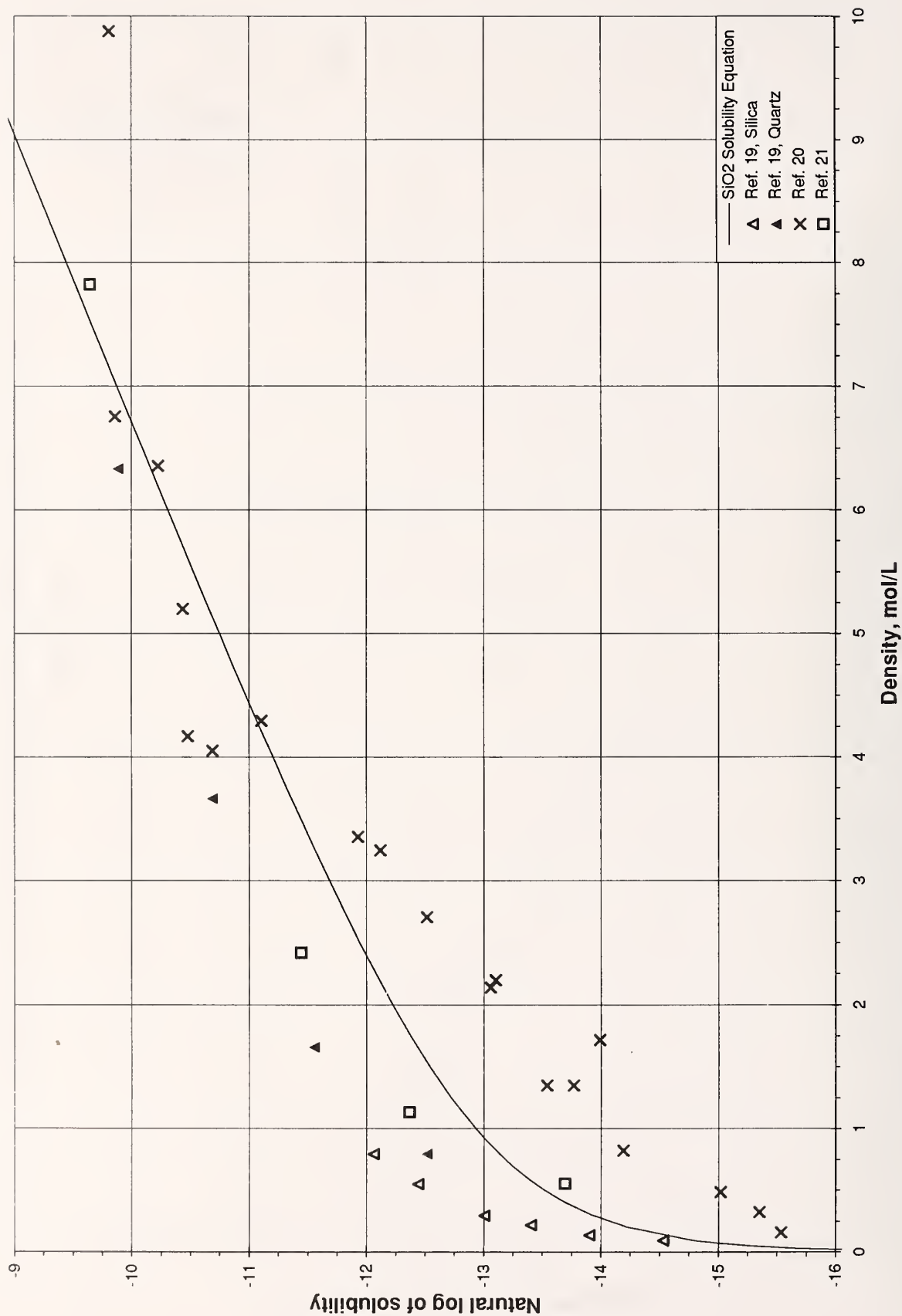


Figure 12. Calculated and experimental solubilities for SiO<sub>2</sub> at 500 °C ± 10 °C.

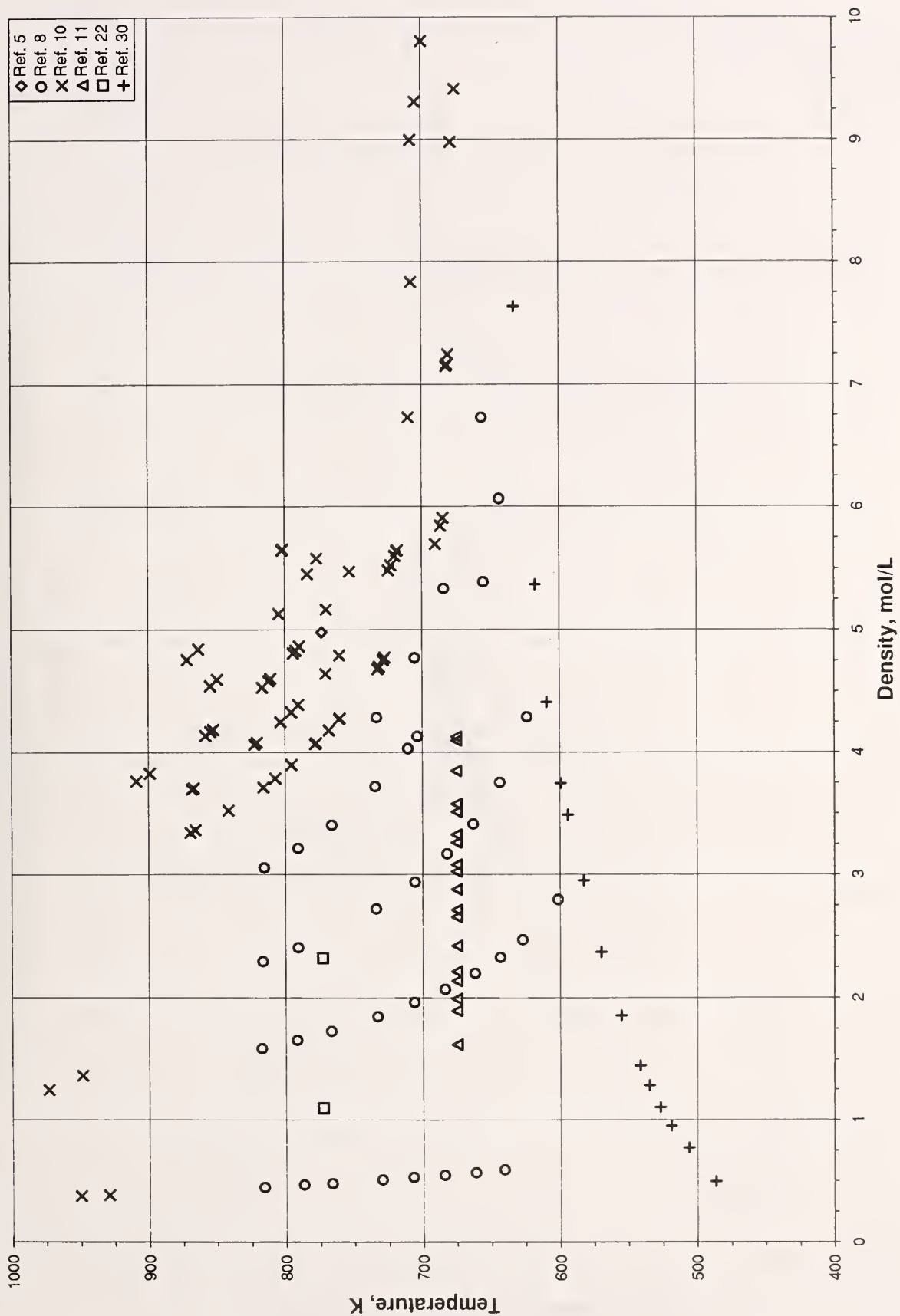
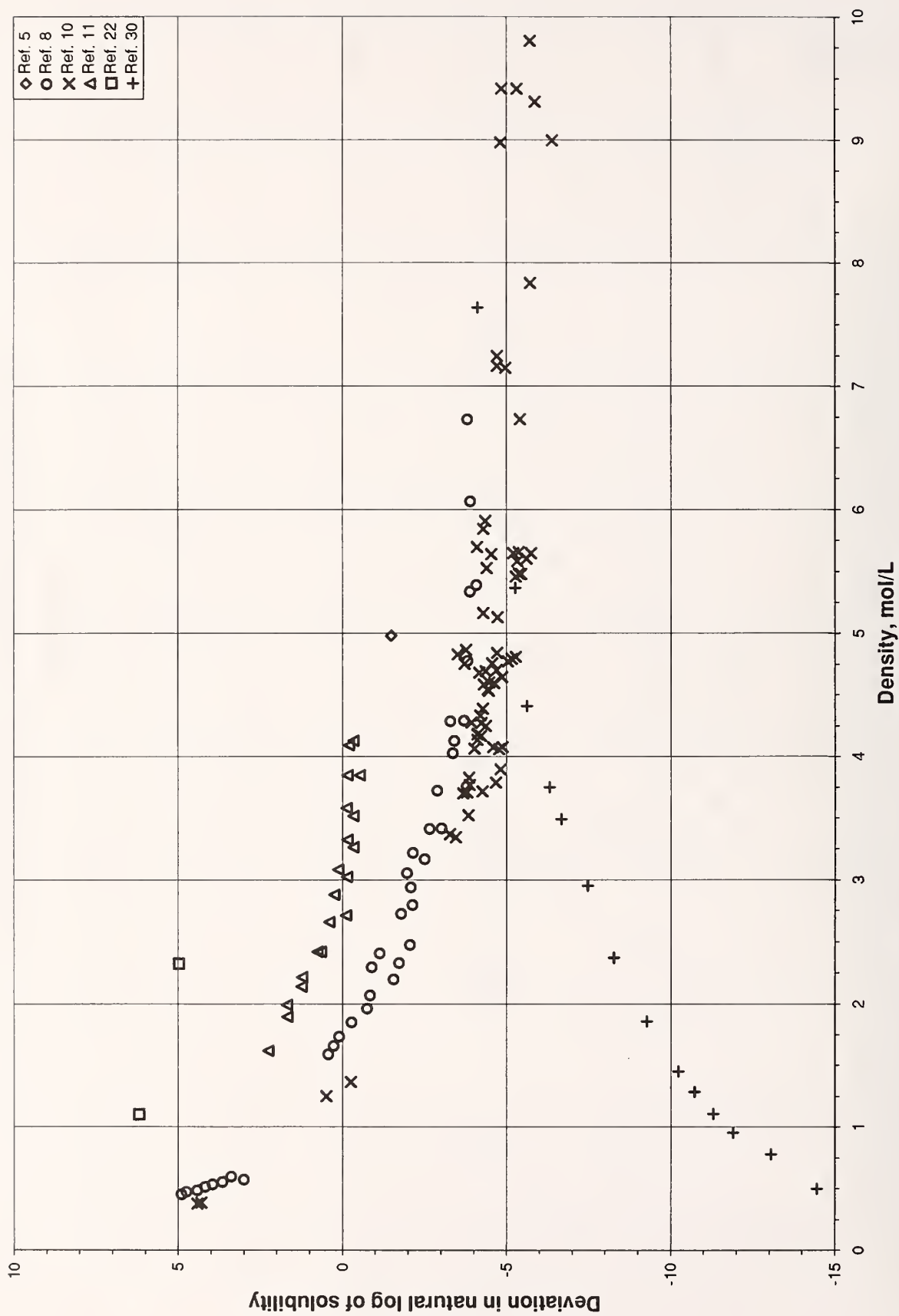


Figure 13. Temperatures and densities of  $\text{Na}_2\text{SO}_4$  data.





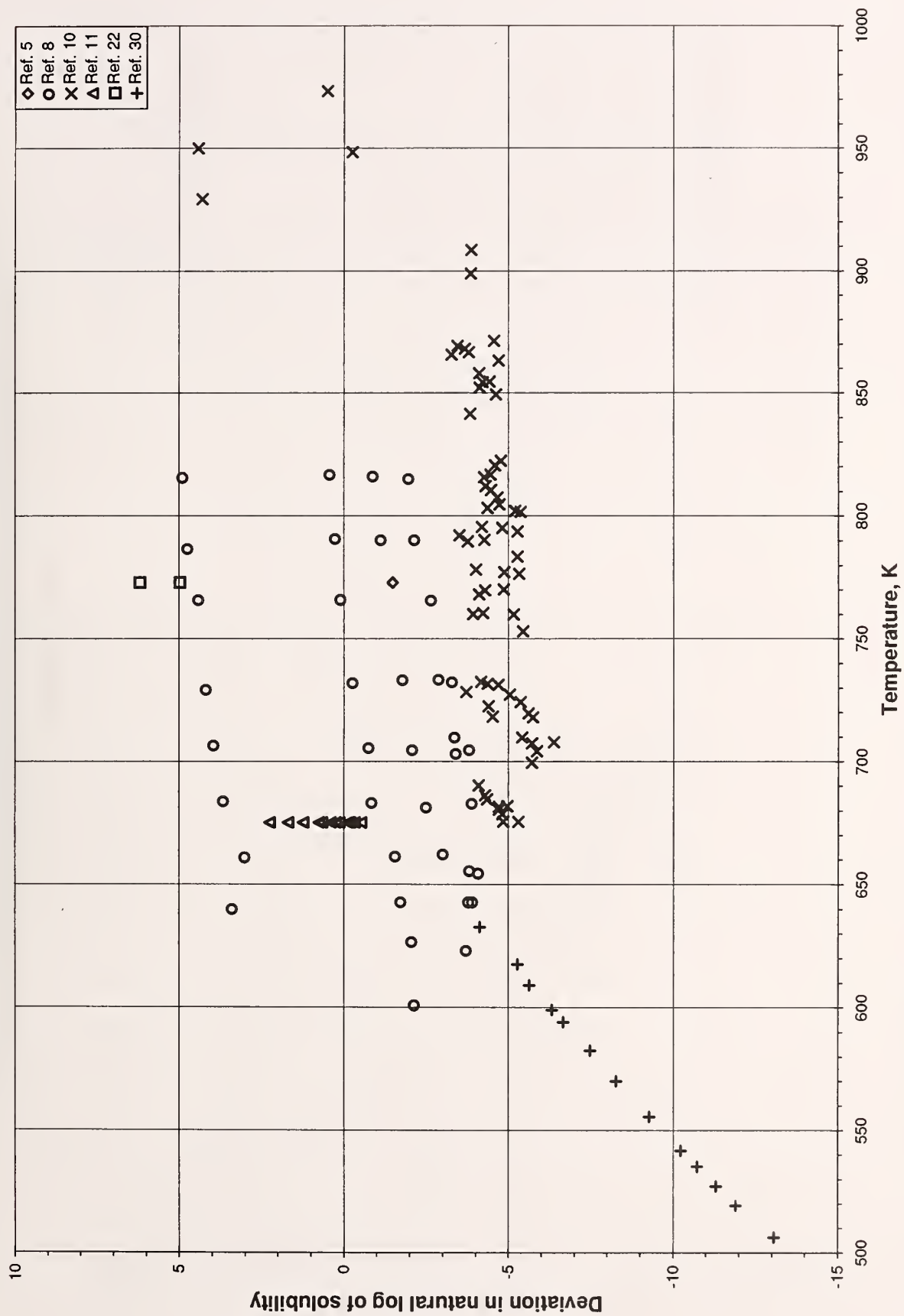


Figure 15. Deviation of data from  $\text{Na}_2\text{SO}_4$  solubility equation.

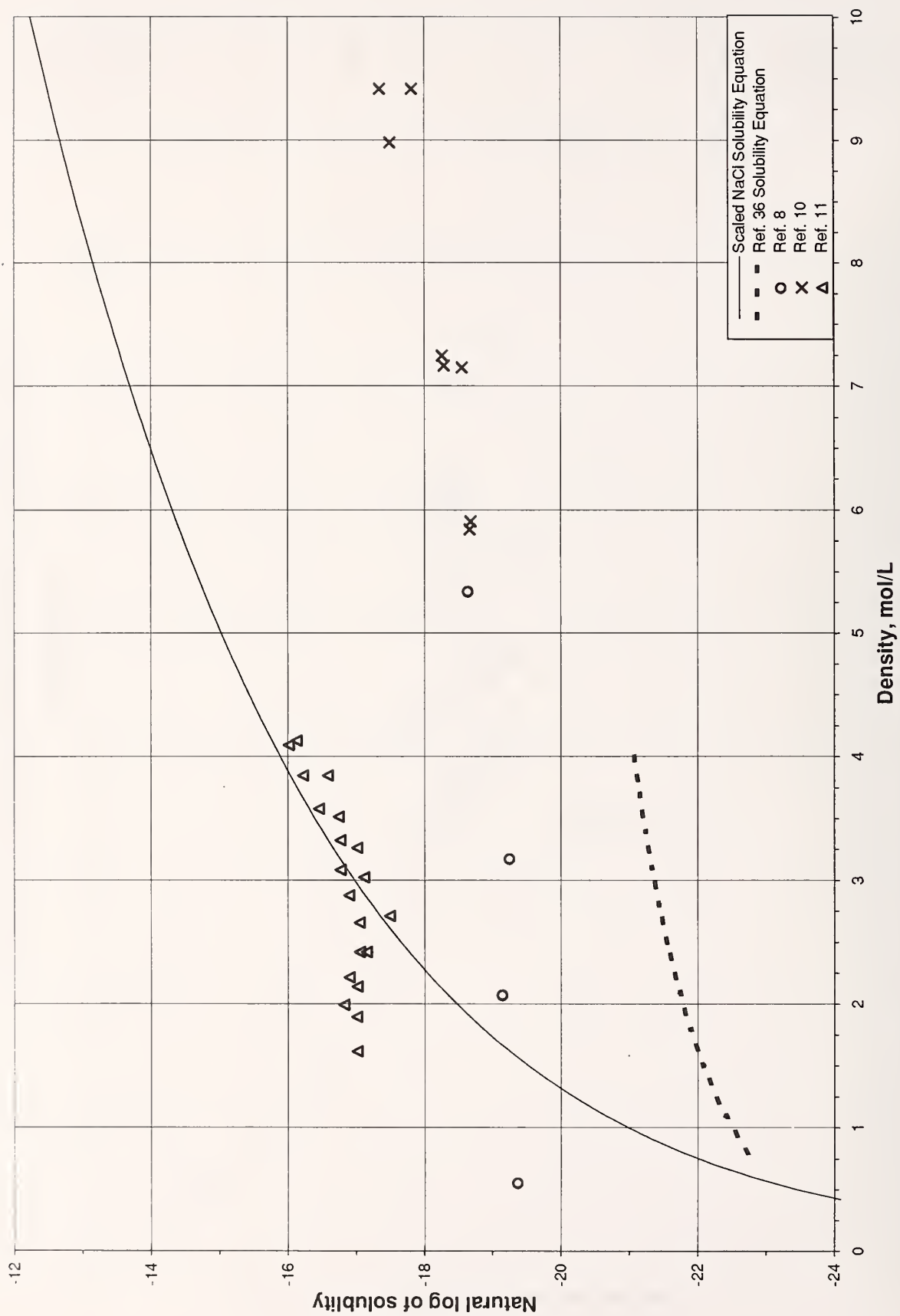


Figure 16. Calculated and experimental solubilities for  $\text{Na}_2\text{SO}_4$  at  $405 \text{ }^\circ\text{C} \pm 10 \text{ }^\circ\text{C}$ .

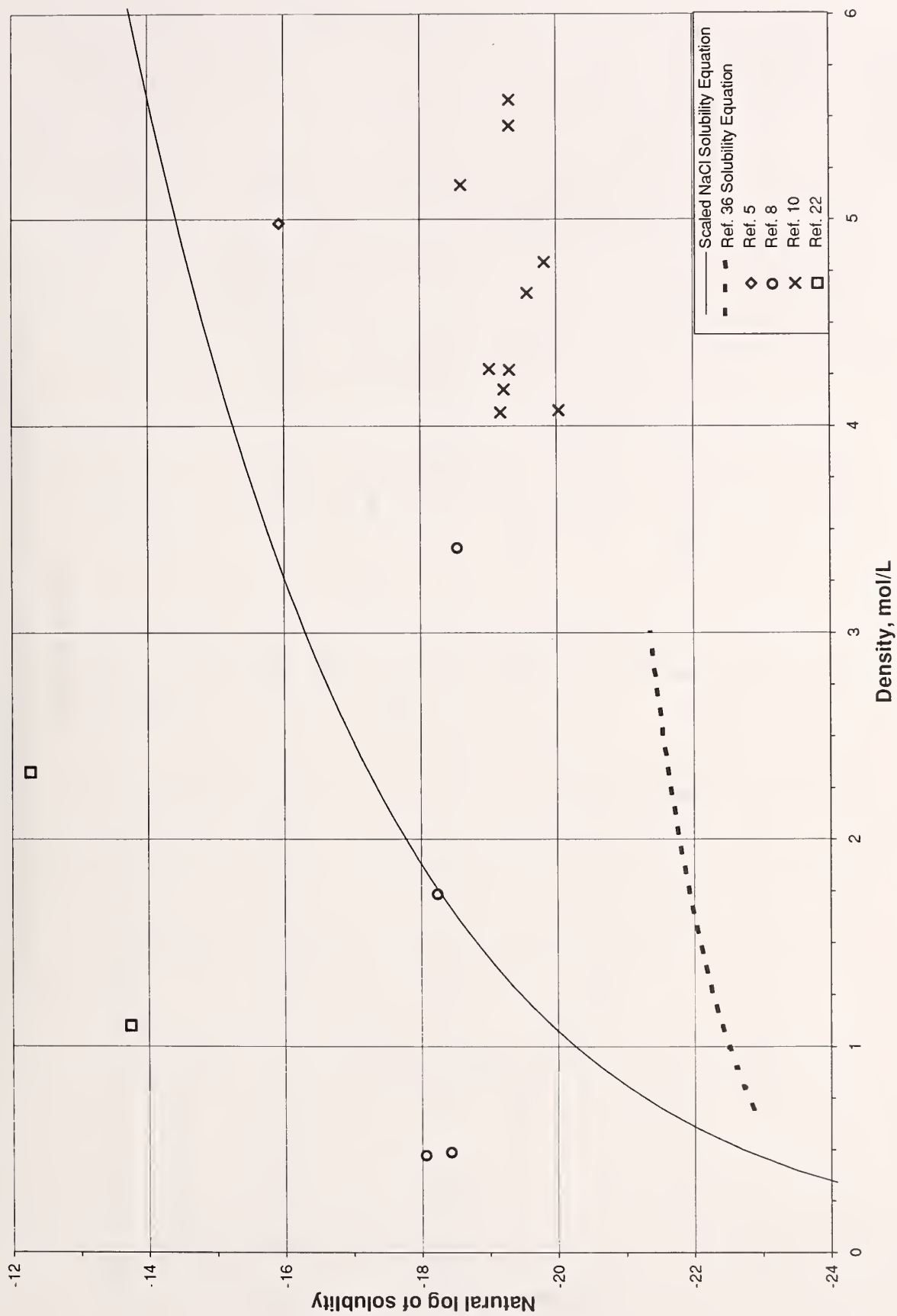


Figure 17. Calculated and experimental solubilities for  $\text{Na}_2\text{SO}_4$  at  $500^\circ\text{C} \pm 15^\circ\text{C}$ .

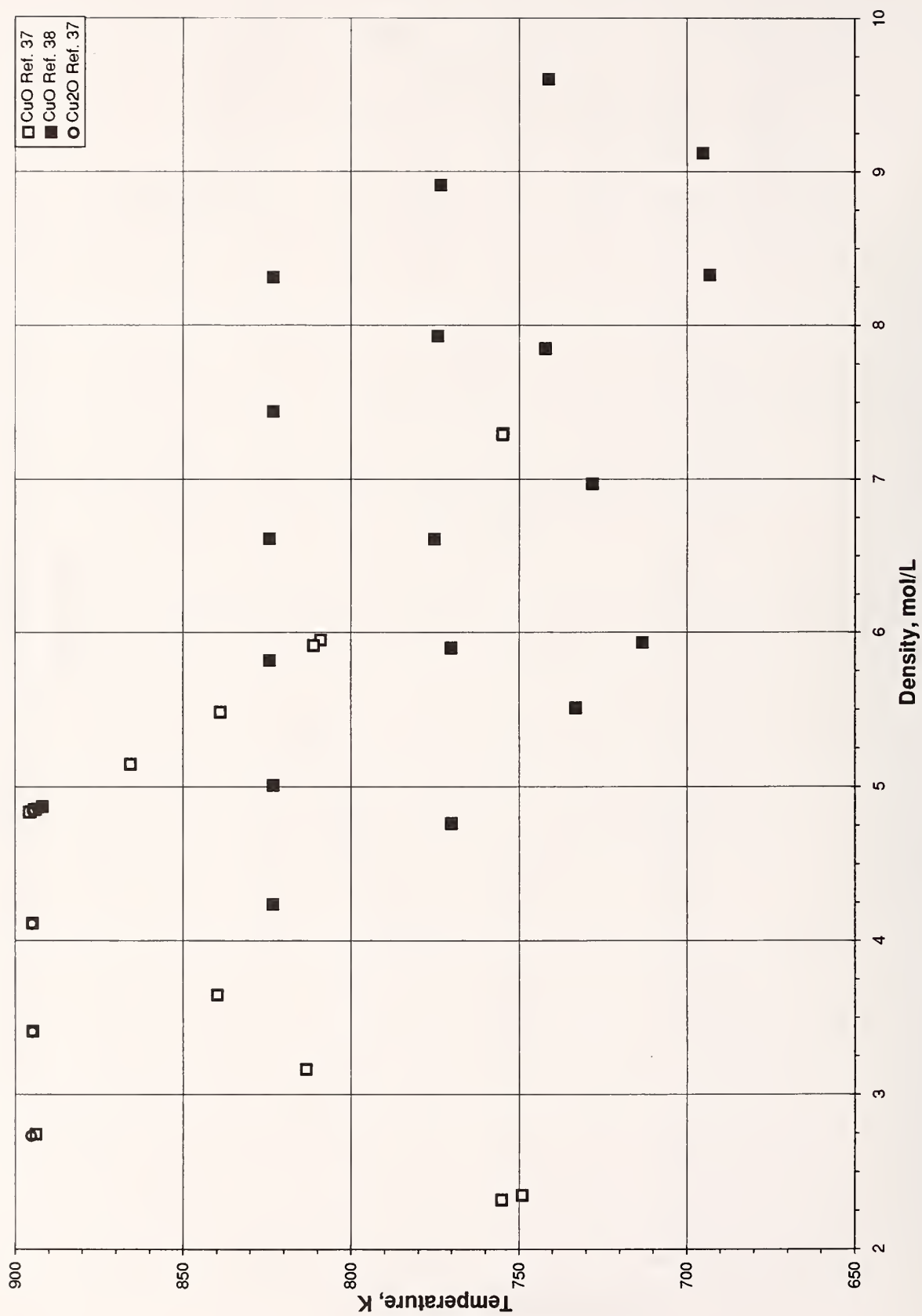


Figure 18. Temperatures and densities of CuO and Cu<sub>2</sub>O data.



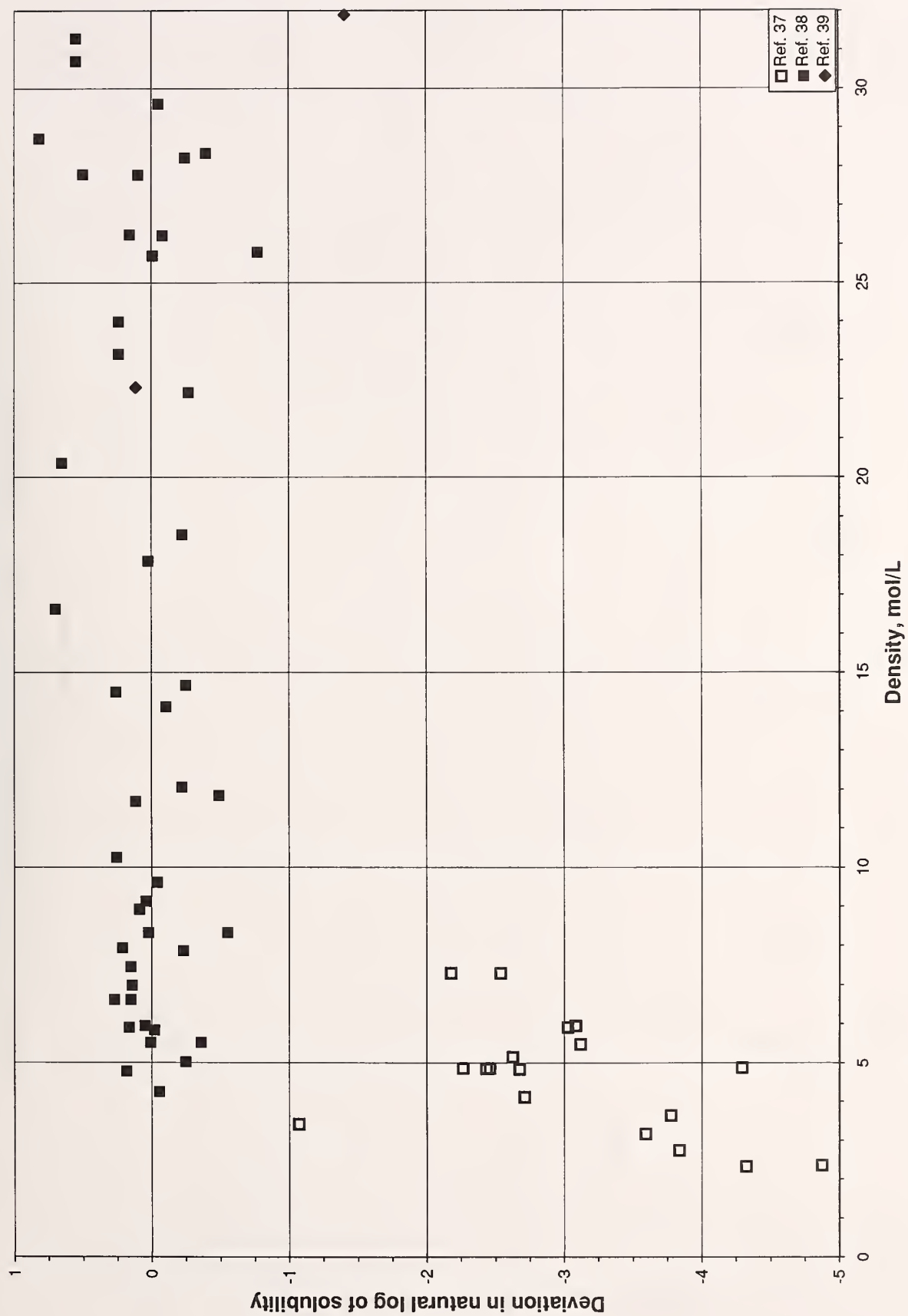


Figure 19. Deviation of data from CuO solubility equation (fit to ref. 38 data).

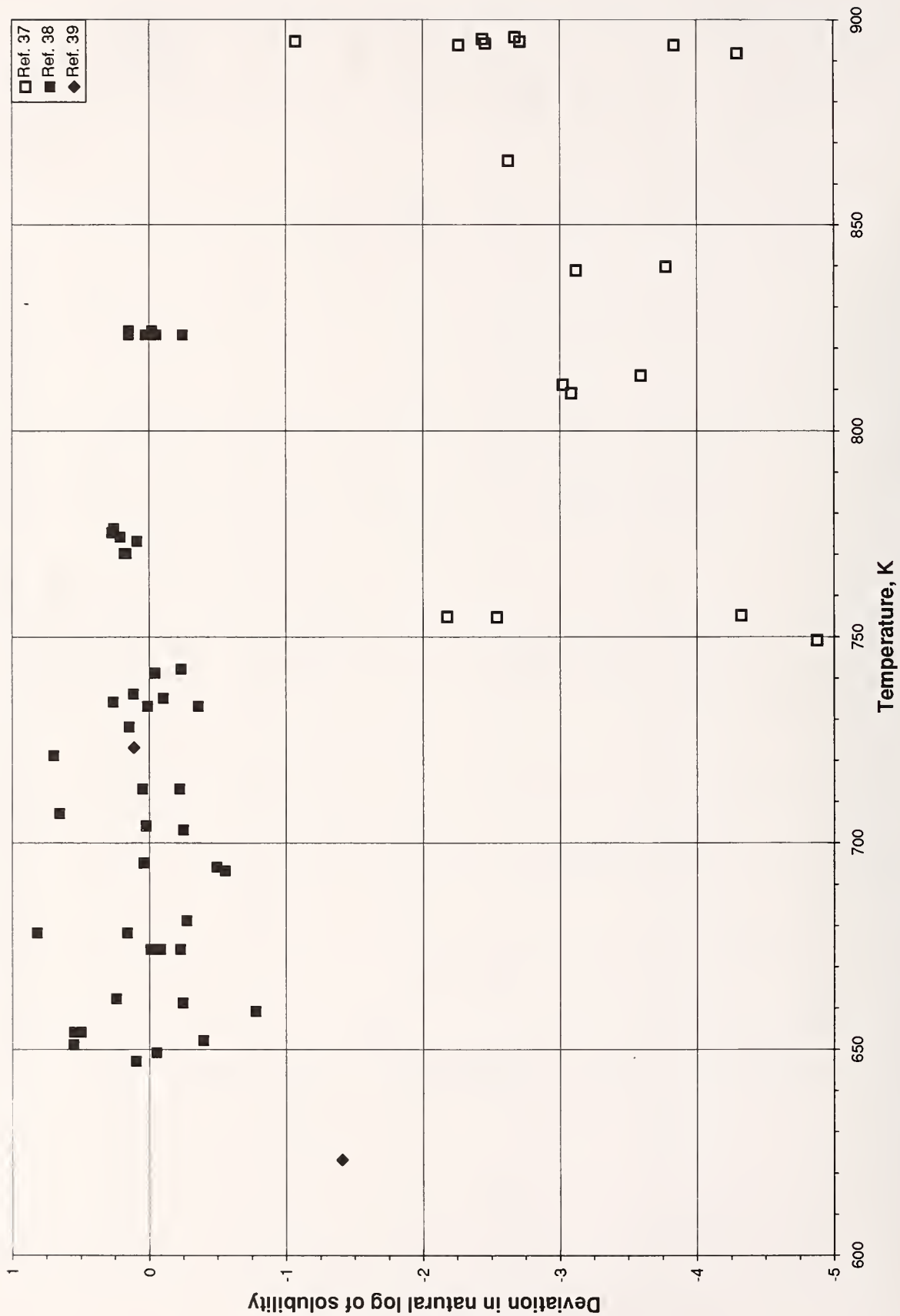
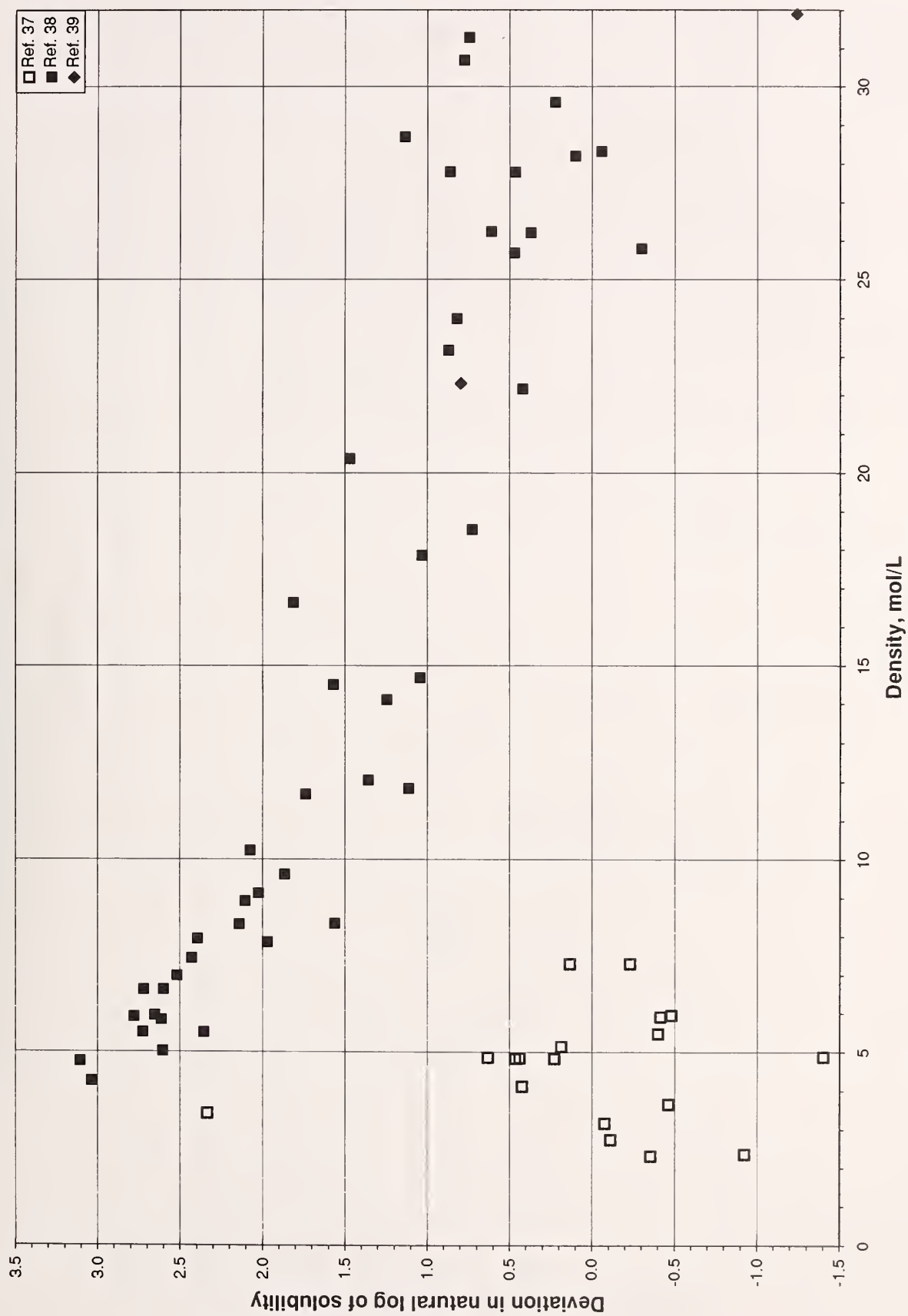


Figure 20. Deviation of data from CuO solubility equation (fit to ref. 38 data).



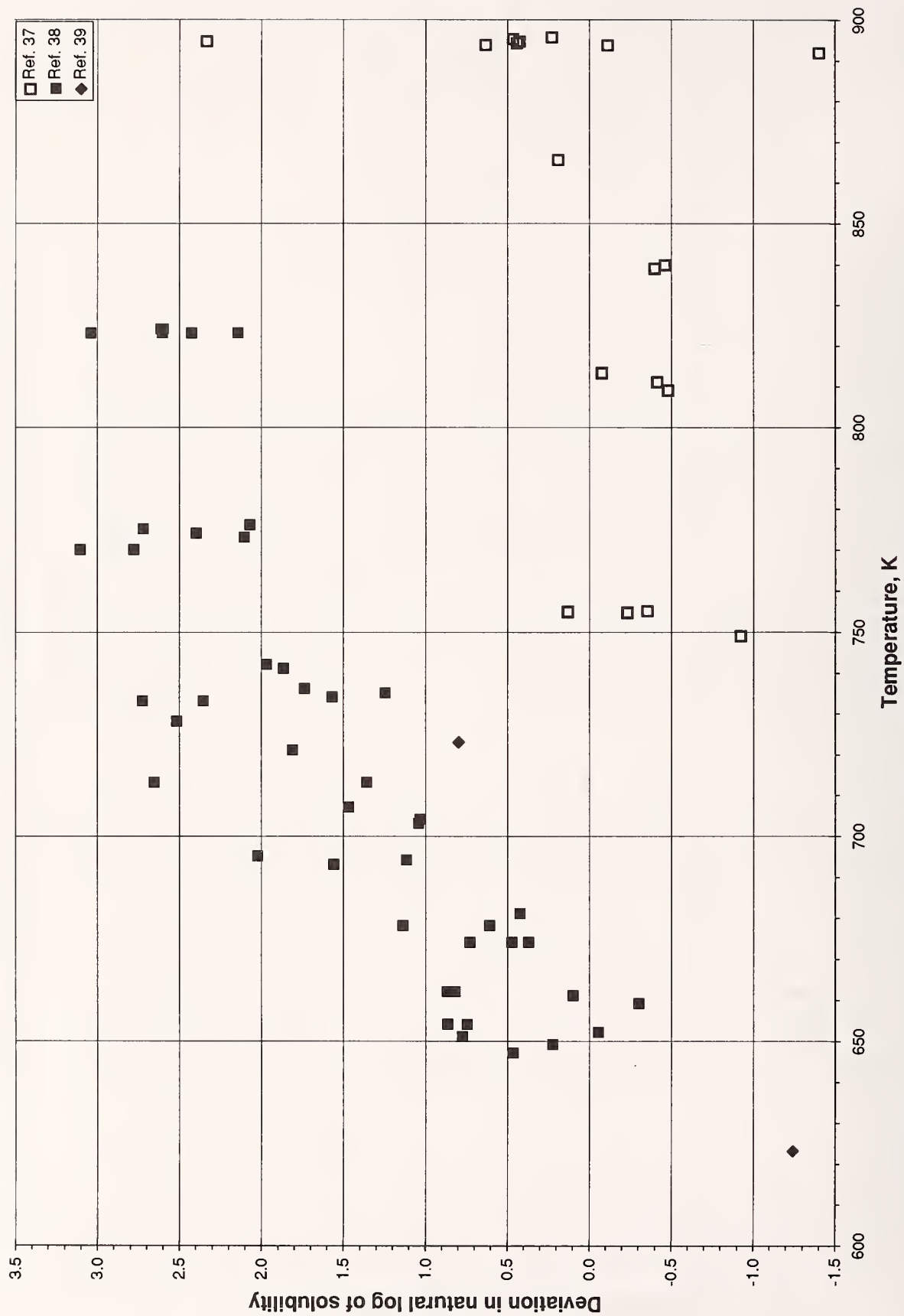


Figure 22. Deviation of data from CuO solubility equation (fit to ref. 37 data).



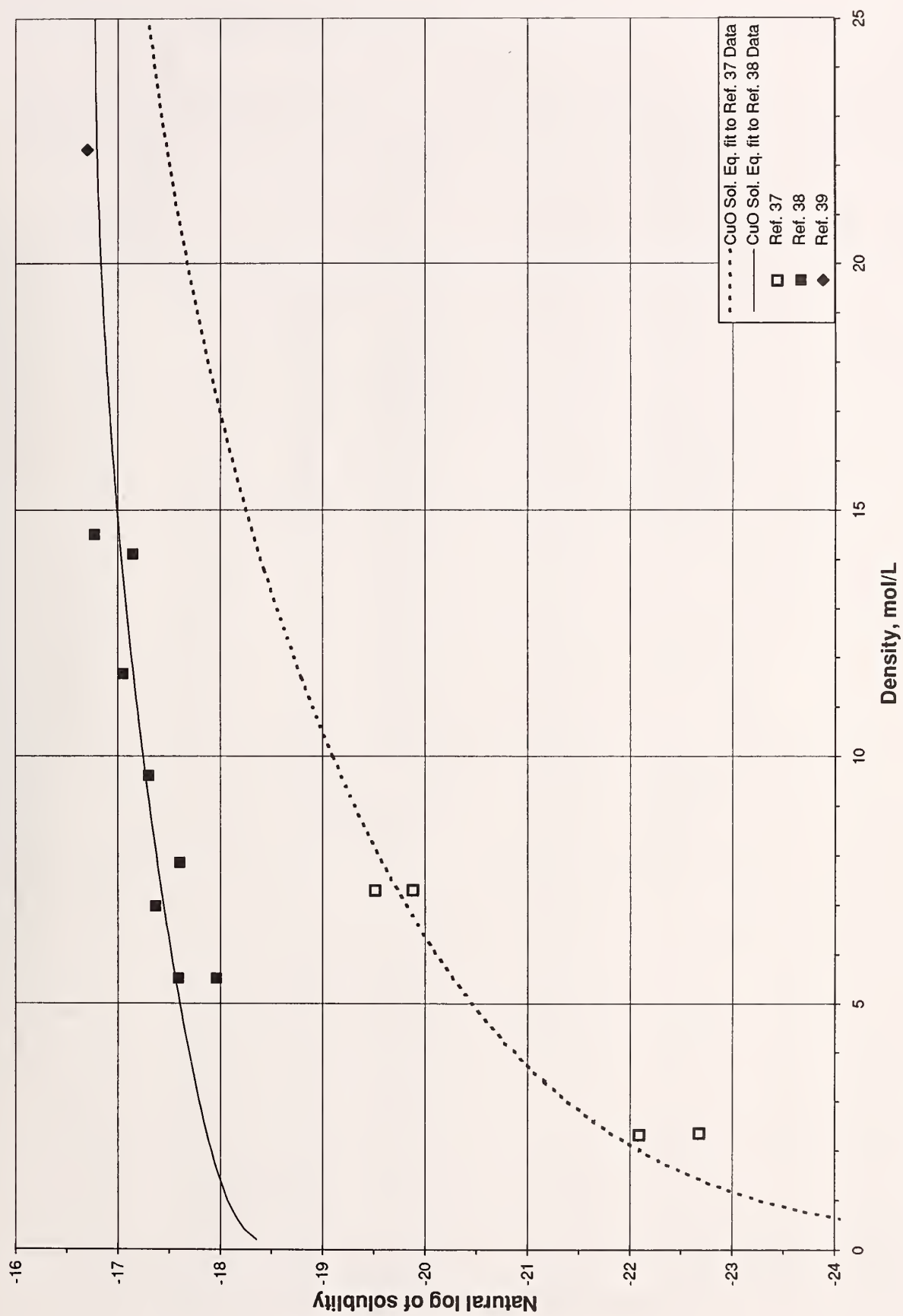


Figure 23. Calculated and experimental solubilities for CuO at 740 K ± 17 K.

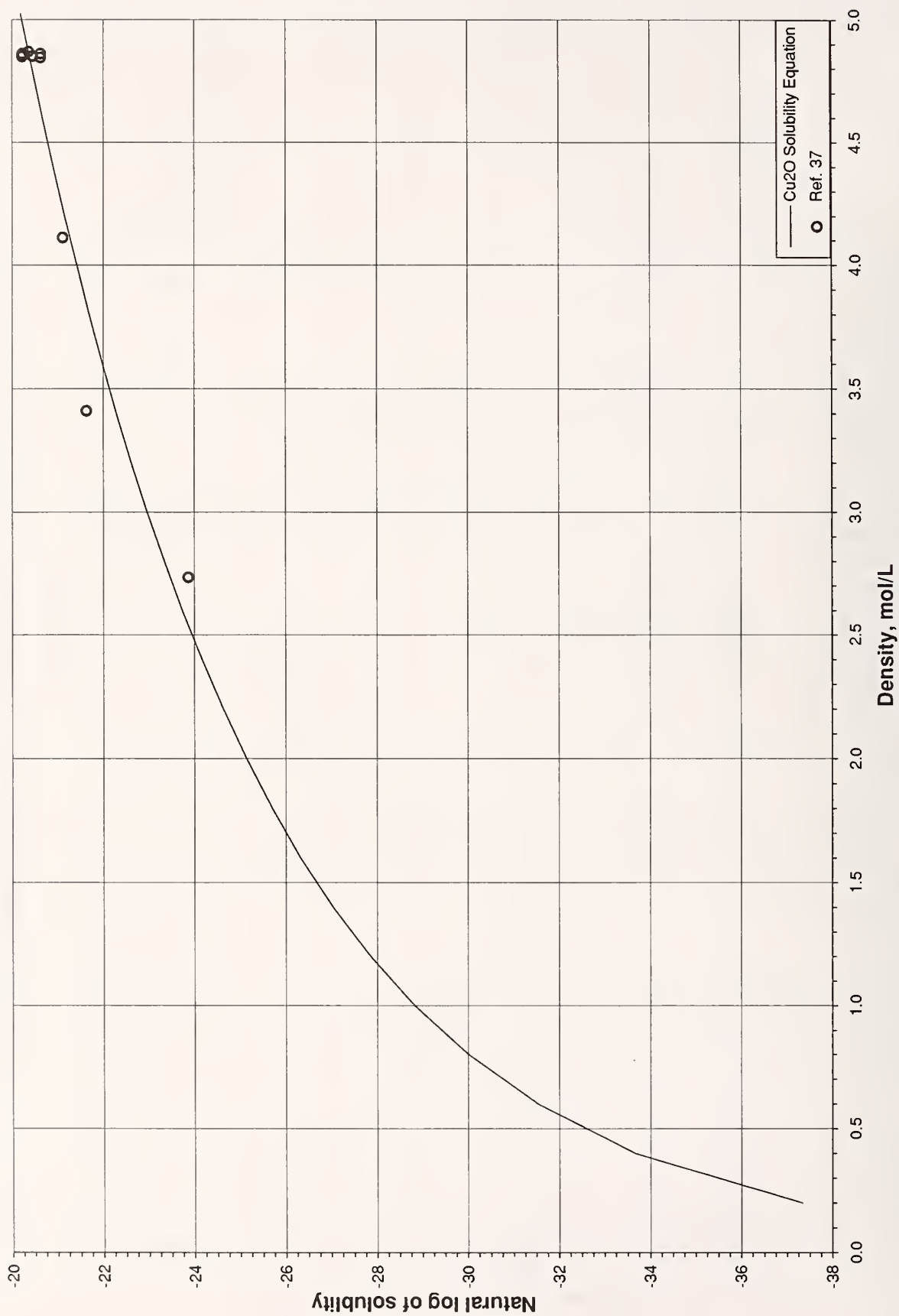


Figure 24. Calculated and experimental solubilities for  $\text{Cu}_2\text{O}$  at  $893.6 \text{ K} \pm 1.5 \text{ K}$ .

## APPENDIX A - SOLUBILITY DATA

### Compound: Cupric Oxide (CuO)

**Reference:** Pocock, F.J. and Stewart, J.F., 1963, The solubility of copper and its oxides in supercritical steam: Journal of Engineering for Power, v. 85, p. 33-45

37

Units of original measurements: Temperature in degrees F, Pressure in psig, Solubility in ppb of Cu

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
749.04	12.8566	2.349	1.4175E-10
754.76	31.1276	7.295	2.3247E-09
754.93	31.1276	7.289	3.3453E-09
755.26	12.8566	2.318	2.5515E-10
809.09	31.1276	5.951	1.6443E-09
811.09	31.1276	5.916	1.7577E-09
813.37	18.7171	3.165	8.2215E-10
838.93	31.1276	5.484	1.7860E-09
839.82	22.1645	3.647	8.2215E-10
865.59	31.1276	5.150	3.2602E-09
891.87	31.1276	4.874	6.8040E-10
893.82	31.1276	4.856	5.2164E-09
893.87	18.7171	2.743	9.3555E-10
894.26	31.1276	4.852	4.3092E-09
894.71	22.8539	3.413	1.5706E-08
894.71	26.9908	4.116	3.2035E-09
895.32	31.1276	4.841	4.4226E-09
895.82	31.1276	4.837	3.4870E-09

**Reference:** Hearn, B., Hunt, M. R. and Hayward, A., 1969, Solubility of cupric oxide in pure subcritical and supercritical water: Journal of Chemical and Engineering Data, v. 14, n. 4, p. 442-447

38

Units of original measurements: Temperature in degrees C, Pressure in psig, Solubility in ppb of Cu

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
330.15	12.0292	54.945	3.5154E-09
342.15	8.3750	54.506	4.5360E-09
354.15	7.6855	54.095	6.5205E-09
360.15	26.5082	54.338	6.6622E-09
361.15	26.6460	54.306	6.0952E-09
362.15	27.3355	54.286	4.8195E-09
383.15	22.8539	53.376	6.6622E-09
390.15	25.6118	53.156	8.2215E-09
394.15	24.3708	52.954	1.0773E-08
395.15	23.8882	52.899	6.5205E-09
406.15	8.3750	51.982	7.3710E-09
427.15	8.3750	50.941	1.4742E-08
454.15	18.3034	49.795	5.6133E-08
460.15	13.9253	49.292	4.0540E-08
480.15	13.2013	48.024	6.0102E-08

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
505.15	20.9579	46.675	7.9663E-08
507.15	26.7839	46.806	8.1931E-08
522.15	20.0961	45.382	1.0206E-07
525.15	20.9234	45.196	1.1085E-07
533.15	26.1634	44.865	1.1142E-07
533.15	26.9908	44.912	1.0716E-07
533.15	28.6110	45.002	1.1198E-07
546.15	22.1645	43.549	1.2587E-07
564.15	28.0595	42.361	1.4260E-07
571.15	22.3368	41.210	1.4629E-07
580.15	29.0592	40.897	1.5507E-07
595.15	22.6471	38.509	1.7294E-07
604.15	29.0592	38.208	1.7010E-07
623.15	27.6803	35.298	1.3098E-07
623.15	41.4697	37.486	1.6160E-07
647.15	24.2329	27.786	6.6339E-08
649.15	27.6803	29.599	5.4999E-08
651.15	31.1276	30.694	9.5539E-08
652.15	27.3355	28.323	3.8839E-08
654.15	27.6803	27.798	9.3838E-08
654.15	34.5750	31.285	9.0720E-08
654.15	38.0224	32.326	9.9225E-08
655.15	41.4697	33.012	1.3778E-07
659.15	28.0250	25.796	2.5231E-08
661.15	31.8171	28.209	4.2808E-08
662.15	27.6458	23.163	6.4354E-08
662.15	28.0595	23.989	6.6055E-08
674.15	29.7831	18.539	3.3169E-08
674.15	34.5750	25.687	5.1597E-08
674.15	35.2645	26.217	4.8195E-08
678.15	37.1605	26.234	6.0669E-08
678.15	41.9524	28.707	1.1510E-07
681.15	34.0579	22.172	3.6571E-08
693.15	26.5771	8.329	1.3041E-08
694.15	30.6795	11.830	1.8144E-08
695.15	27.9216	9.122	2.5515E-08
703.15	34.9887	14.672	2.8350E-08
704.15	38.0224	17.851	4.3375E-08
707.15	41.4697	20.359	8.9302E-08
713.15	23.9226	5.937	2.1829E-08
713.15	34.3682	12.042	2.6082E-08
721.15	41.4008	16.624	8.4766E-08
728.15	27.7492	6.970	2.8633E-08
733.15	24.2329	5.511	1.5876E-08
733.15	24.2329	5.511	2.2963E-08
734.15	41.8145	14.501	5.2164E-08
735.15	41.4697	14.107	3.5721E-08
736.15	37.9534	11.675	3.9406E-08

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
741.15	34.9887	9.603	3.0618E-08
742.15	31.2655	7.848	2.2680E-08
770.15	23.9916	4.764	3.2035E-08
770.15	28.1284	5.901	3.4303E-08
773.15	37.5052	8.910	3.9123E-08
774.15	34.8852	7.931	4.1958E-08
775.15	30.8863	6.606	4.1107E-08
776.15	41.3318	10.234	5.0463E-08
823.15	24.4397	4.241	3.2602E-08
823.15	28.0250	5.011	2.8350E-08
823.15	38.0913	7.439	4.8762E-08
823.15	41.3318	8.311	4.5076E-08
824.15	31.6447	5.821	3.7705E-08
824.15	34.9197	6.609	4.6777E-08

**Reference:** Varyash, L.N., 1986, Hydrolysis of Cu(II) at 25-350 degrees C: Geochemistry International, v. 39, n. 1, p. 82-92

*Units of original measurements: Temperature in degrees C, Solubility in molality, \* indicates data point is at saturation*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
623.15	16.5294	31.901	1.8916E-08 *
723.15	50.0000	22.317	5.5667E-08

## Compound: Cuprous Oxide (Cu<sub>2</sub>O)

**Reference:** Pocock, F.J. and Stewart, J.F., 1963, The solubility of copper and its oxides in supercritical steam: Journal of Engineering for Power, v. 85, p. 33-45

*Units of original measurements: Temperature in degrees F, Pressure in psig, Solubility in ppb of Cu*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
892.21	31.1276	4.871	1.4033E-09
892.93	31.1276	4.864	1.0915E-09
893.04	31.1276	4.863	1.6301E-09
894.09	31.1276	4.853	1.2899E-09
894.21	31.1276	4.852	1.6301E-09
894.59	31.1276	4.848	1.0915E-09
894.71	22.8539	3.413	3.9690E-10
894.71	26.9908	4.116	6.6622E-10
895.04	18.7171	2.738	4.2525E-11



**Compound: Quartz (SiO<sub>2</sub>)**

**Reference:** Heitmann, H.G., 1964, Solubility of silicic acid in water and steam and their influence on turbine silication: Chemiker-Ztg./Chem. Apparatur, v. 88, n. 22, p. 891-893

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
425.15	0.0981	0.028	6.8962E-09
433.15	29.4200	51.271	3.6283E-05
435.15	0.0981	0.027	7.7957E-09
440.15	0.2942	0.082	1.3792E-08
473.15	0.2942	0.076	1.5891E-08
478.15	29.4200	48.784	7.7671E-05
488.15	0.0981	0.024	1.0194E-08
508.15	0.2942	0.070	2.2787E-08
513.15	29.4200	46.511	1.2627E-04
525.15	0.5884	0.138	4.1377E-08
525.15	3.1381	0.823	5.9967E-08
543.15	0.0981	0.022	1.6191E-08
548.15	0.2942	0.065	2.8184E-08
553.15	29.4200	43.430	1.9288E-04
573.15	4.9033	1.196	3.7779E-07
573.15	29.4200	41.620	2.2619E-04
577.15	3.1381	0.711	1.4992E-07
583.15	0.2942	0.061	4.1077E-08
588.15	0.5884	0.122	7.7357E-08
589.15	0.0981	0.020	2.6086E-08
603.15	29.4200	38.378	2.7542E-04
613.15	0.0981	0.019	4.1077E-08
623.15	0.2942	0.057	6.3865E-08
623.15	4.9033	1.045	6.5364E-07
626.15	9.8066	2.381	2.0839E-06
627.15	3.1381	0.638	3.8079E-07
633.15	29.4200	33.964	2.8743E-04
655.15	0.0981	0.018	5.3370E-08
658.15	0.5884	0.108	1.5172E-07
663.15	0.2942	0.054	1.1484E-07
663.15	29.4200	25.381	1.8388E-04
673.15	4.9033	0.940	1.1634E-06
673.15	9.8066	2.051	3.1483E-06
673.15	19.6133	5.386	1.3793E-05
674.15	3.1381	0.584	6.7163E-07
681.15	29.4200	13.678	9.8368E-05
683.15	0.5884	0.104	1.9789E-07
703.15	0.0981	0.017	9.6846E-08
711.15	0.2942	0.050	1.5052E-07
717.15	29.4200	8.303	4.6479E-05
722.15	19.6133	4.264	1.6791E-05
723.15	4.9033	0.859	2.8424E-06
723.15	9.8066	1.823	5.3071E-06
768.15	29.4200	6.333	5.0978E-05

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
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773.15	4.9033	0.793	3.6580E-06
773.15	9.8066	1.656	9.5649E-06
773.15	19.6133	3.663	2.2789E-05
820.15	29.4200	5.366	6.3574E-05
823.15	3.1381	0.467	3.4181E-06
823.15	9.8066	1.525	1.4632E-05
823.15	19.6133	3.275	3.4484E-05
827.15	4.9033	0.734	3.7479E-06
862.15	19.6133	3.044	4.0181E-05
863.15	29.4200	4.841	7.7371E-05
865.15	4.9033	0.698	8.0057E-06
865.15	9.8066	1.433	1.9100E-05

**Reference:** Wendlandt, H.G., 1963, Reaktionen zwischen Oxiden und Wasser bei höheren Temperaturen und verschiedenen Dichten: Dissertation - University of Göttingen

Units of original measurements: Temperature in degrees C, Pressure in atm, Solubility in mg/kg

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	2.1278	0.391	2.0988E-07
673.15	4.5596	0.869	4.4975E-07
673.15	6.5861	1.298	6.8962E-07
673.15	9.3219	1.931	9.5947E-07
673.15	10.6391	2.264	1.4092E-06
673.15	15.1988	3.609	2.8484E-06
673.15	18.2385	4.759	3.8379E-06
673.15	20.2650	5.715	5.5770E-06
673.15	22.2915	6.917	1.1094E-05
673.15	25.3313	9.627	1.9490E-05
673.15	27.8644	14.061	3.8082E-05
673.15	28.8776	16.805	5.7276E-05
673.15	29.8909	19.577	1.0257E-04
673.15	35.4637	26.688	1.8658E-04
673.15	40.5300	29.264	2.4630E-04
773.15	1.0133	0.159	1.7990E-07
773.15	2.0265	0.320	2.1588E-07
773.15	3.0398	0.484	2.9983E-07
773.15	5.0663	0.821	6.8962E-07
773.15	8.1060	1.348	1.3193E-06
773.15	8.1060	1.348	1.0494E-06
773.15	10.1325	1.716	8.3954E-07
773.15	12.3616	2.139	2.1288E-06
773.15	12.6656	2.198	2.0389E-06
773.15	15.1988	2.706	3.6580E-06
773.15	17.7319	3.243	5.4570E-06
773.15	18.2385	3.355	6.5964E-06
773.15	21.2783	4.052	2.2789E-05
773.15	21.7849	4.173	2.8186E-05
773.15	22.2915	4.296	1.4992E-05
773.15	25.8379	5.204	2.9386E-05

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
773.15	29.8909	6.355	3.6283E-05
773.15	31.2081	6.758	5.2177E-05
773.15	40.0234	9.881	5.4877E-05
773.15	40.5300	10.084	8.5770E-05
773.15	50.6625	14.579	1.5177E-04

**Reference:** Morey, G.W. and Hesselgesser, J.M., 1950, The solubility of quartz and some other substances in superheated steam at high pressures: Joint Research Committee on Boiler Feedwater Studies and the Power Division Annual Meeting, ASME Paper No. 50-A-73, p. 865-875

Units of original measurements: Temperature in degrees C, Pressure in psia, Solubility in ppm

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
633.15	34.4737	35.053	2.5561E-04
673.15	3.4474	0.646	3.1183E-07
673.15	6.8947	1.366	9.2949E-07
673.15	13.7895	3.154	1.5591E-06
673.15	34.4737	25.969	1.9108E-04
673.15	68.9473	35.301	3.7782E-04
673.15	103.4210	38.737	4.5052E-04
773.15	3.4474	0.551	1.1304E-06
773.15	6.8947	1.134	4.2577E-06
773.15	13.7895	2.420	1.0704E-05
773.15	34.4737	7.825	6.4774E-05
773.15	68.9473	22.188	4.0456E-04
773.15	103.4210	29.853	7.7978E-04

**Reference:** Morey, G.W. and Hesselgesser, J.M., 1951, The solubility of some minerals in superheated steam at high pressures: Economic Geology, v. 46, p. 821-835

Units of original measurements: Temperature in degrees C, Pressure in psia, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	150.0000	41.701	6.2156E-04
673.15	200.0000	43.992	6.9975E-04
773.15	150.0000	34.971	1.2148E-03
773.15	200.0000	38.380	1.5014E-03
873.15	33.3000	5.490	1.0797E-04
873.15	100.0000	20.772	8.8935E-04
873.15	150.0000	28.192	1.6827E-03
873.15	200.0000	32.714	2.3061E-03

**Reference:** Kennedy, G.C., 1950, A portion of the system silica-water: Economic Geology, v. 45, p. 629-653

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
433.15	0.6200	50.371	2.0989E-05

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
455.15	1.1100	49.117	5.0978E-05
473.15	1.5500	47.996	7.1972E-05
495.15	2.5000	46.497	1.0797E-04
513.15	3.3500	45.149	1.2897E-04
529.15	100.0000	48.325	1.8898E-04
536.15	5.1700	43.234	1.7097E-04
553.15	6.4200	41.647	1.8898E-04
553.15	100.0000	46.926	2.3400E-04
573.15	8.5900	39.530	2.0398E-04
573.15	30.0000	41.668	2.3100E-04
573.15	30.0000	41.668	2.3100E-04
590.15	50.0000	41.664	2.6101E-04
590.15	100.0000	44.594	3.1506E-04
591.15	10.6700	37.302	2.1299E-04
593.15	20.0000	38.415	2.4000E-04
598.15	15.0000	36.906	2.3100E-04
598.15	30.0000	39.043	2.6402E-04
599.15	25.0000	38.308	2.4600E-04
603.15	12.8100	35.568	2.2199E-04
603.15	75.0000	42.299	3.1205E-04
606.15	100.0000	43.514	3.5710E-04
609.15	25.0000	36.956	2.5801E-04
610.15	20.0000	35.895	2.4000E-04
612.15	15.0000	34.262	2.2799E-04
614.15	30.0000	37.038	2.7302E-04
616.15	50.0000	39.208	3.1506E-04
619.15	15.6500	32.751	2.0999E-04
621.15	35.0000	36.848	2.9104E-04
623.15	20.0000	33.340	2.4000E-04
623.15	100.0000	42.316	4.0516E-04
628.15	30.0000	34.956	2.9104E-04
628.15	75.0000	40.259	3.6911E-04
631.15	25.0000	33.153	2.6101E-04
633.15	18.6700	29.286	1.7097E-04
633.15	18.6700	29.286	1.8298E-04
633.15	18.6700	29.286	1.6797E-04
633.15	20.0000	30.419	2.0999E-04
633.15	30.0000	34.104	2.9104E-04
634.15	40.0000	35.875	3.2106E-04
638.15	20.0000	27.832	1.9048E-04
639.15	35.0000	34.208	3.1205E-04
641.15	20.0000	8.513	1.3947E-04
641.15	20.5100	26.182	1.3947E-04
641.15	50.0000	36.453	3.5410E-04
642.15	25.0000	30.325	2.2799E-04
642.15	30.0000	32.360	2.7002E-04
645.15	30.0000	31.698	2.6702E-04
646.15	22.1000	22.130	6.8973E-05
647.15	25.0000	28.501	1.7697E-04
648.15	25.0000	28.059	1.8298E-04
651.15	75.0000	38.203	4.3220E-04



<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
653.15	25.0000	25.024	1.3797E-04
653.15	50.0000	34.946	3.5410E-04
654.15	30.0000	29.340	2.3400E-04
655.15	100.0000	39.910	4.8328E-04
658.15	30.0000	28.031	2.1899E-04
658.15	35.0000	30.544	2.8503E-04
662.15	25.0000	12.500	4.7979E-05
663.15	30.0000	26.023	1.9048E-04
664.15	30.0000	25.552	1.8298E-04
665.15	35.0000	28.792	2.4600E-04
665.15	40.0000	30.784	3.0605E-04
667.15	125.0000	40.679	5.6744E-04
668.15	50.0000	32.840	3.5710E-04
669.15	50.0000	32.689	3.5410E-04
670.15	30.0000	22.018	1.4397E-04
673.15	35.0000	26.365	2.2799E-04
674.15	60.0000	33.868	4.1417E-04
680.15	40.0000	27.323	2.8203E-04
681.15	30.0000	14.783	8.6969E-05
683.15	60.0000	32.689	4.0816E-04
683.15	75.0000	35.003	4.6224E-04
684.15	100.0000	37.546	5.4339E-04
686.15	175.0000	42.162	7.6594E-04
689.15	100.0000	37.121	5.5842E-04
693.15	35.0000	18.000	1.4547E-04
696.15	50.0000	28.021	3.3307E-04
700.15	150.0000	39.952	7.2081E-04
701.15	35.0000	15.236	1.1847E-04
702.15	150.0000	39.820	8.1409E-04
703.15	40.0000	20.231	1.9648E-04
708.15	175.0000	40.848	9.1946E-04
709.15	75.0000	32.076	4.8027E-04
711.15	50.0000	24.928	2.9704E-04
715.15	60.0000	27.927	4.0215E-04
715.15	150.0000	38.954	8.3215E-04
722.15	75.0000	30.504	4.7727E-04
725.15	100.0000	33.906	6.3659E-04
726.15	40.0000	14.485	1.3797E-04
728.15	50.0000	21.247	2.7753E-04
748.15	50.0000	17.497	2.4150E-04
751.15	60.0000	21.990	3.4509E-04
765.15	100.0000	30.097	7.0276E-04
777.15	75.0000	23.562	4.9079E-04
779.15	50.0000	13.695	1.9948E-04
779.15	60.0000	18.053	3.1806E-04
780.15	60.0000	17.934	3.2106E-04
784.15	50.0000	13.261	1.9348E-04
813.15	50.0000	11.341	1.7697E-04
815.15	100.0000	25.383	7.5090E-04
818.15	60.0000	14.382	3.0004E-04
826.15	75.0000	18.453	4.9830E-04

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
832.15	75.0000	17.954	5.0131E-04
878.15	60.0000	11.297	2.9404E-04
883.15	125.0000	24.348	1.3716E-03

**Reference:** Wyart, J. and Sabatier, G., 1955, Nouvelles mesures de la solubilité du quartz, de la tridymite et de la cristobalite dans l'eau sous pression au-dessus de la température critique: Acad. Sci. Paris Comptes Rendus, v. 240, p. 1905-1907

*Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in g/kg*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
673.15	50.0000	32.072	3.3007E-04
673.15	100.0000	38.464	4.9530E-04
673.15	150.0000	41.701	6.0051E-04
673.15	200.0000	43.992	6.6065E-04

**Reference:** Khitarov, N.I., 1956, The 400 degree isotherm for the system H<sub>2</sub>O-SiO<sub>2</sub> at pressures up to 2000 Kg/cm<sup>2</sup>: Geochemistry International, v. 1, p. 55-61

*Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/L*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
623.15	294.1995	49.344	5.4339E-04
673.15	58.8399	33.802	2.9104E-04
673.15	98.0665	38.305	4.2919E-04
673.15	147.0998	41.547	5.7646E-04
673.15	196.1330	43.835	6.5163E-04
673.15	235.3596	45.307	7.3465E-04
673.15	274.5862	46.574	7.7196E-04
673.15	294.1995	47.148	7.8550E-04
673.15	343.2328	48.453	8.4118E-04
673.15	348.1361	48.574	8.5684E-04
673.15	392.2660	49.609	9.0742E-04
723.15	294.1995	44.903	1.2841E-03

**Reference:** Kitahara, S., 1960, The solubility of quartz in water at high temperatures and pressures: Rev. Phys. Chemistry Japan, v. 30, p. 109-114

*Units of original measurements: Temperature in degrees C, Pressure in atm, Volume in mL/g, Solubility in wt%, \* indicates data point is at saturation*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
433.15	0.6079	50.371	2.3988E-05 *
473.15	1.5199	47.996	7.7971E-05 *
513.15	3.3437	45.149	1.3497E-04 *
553.15	6.3835	41.647	1.7397E-04 *
573.15	8.8153	39.530	1.8598E-04 *
593.15	11.4497	37.029	1.9498E-04 *
613.15	14.6921	33.897	1.9498E-04 *

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
633.15	18.6438	29.286	1.5897E-04 *
643.15	21.0756	25.058	7.4971E-05 *
653.15	23.3990	13.877	5.3977E-05
653.15	23.5724	15.860	6.8973E-05
653.15	23.7312	18.503	8.9969E-05
653.15	23.8961	20.559	1.0797E-04
653.15	24.3314	23.129	1.3197E-04
653.15	25.1031	25.231	1.5897E-04
653.15	27.1334	27.754	2.0098E-04
653.15	32.7120	30.838	2.6101E-04
653.15	48.4744	34.693	3.3608E-04
653.15	65.3194	37.006	3.7512E-04
673.15	27.7892	13.877	6.5974E-05
673.15	28.5439	15.860	8.3970E-05
673.15	29.4771	18.503	1.0797E-04
673.15	30.3171	20.559	1.2897E-04
673.15	31.7689	23.129	1.5597E-04
673.15	33.6049	25.231	1.9198E-04
673.15	37.2416	27.754	2.4000E-04
673.15	45.2020	30.838	3.0905E-04
673.15	64.5426	34.693	3.9314E-04
673.15	83.8407	37.006	4.4121E-04
693.15	32.1272	13.877	8.0970E-05
693.15	33.5192	15.860	1.0197E-04
693.15	35.3620	18.503	1.3197E-04
693.15	36.9723	20.559	1.5597E-04
693.15	39.5247	23.129	1.8898E-04
693.15	42.4728	25.231	2.2799E-04
693.15	47.6931	27.754	2.8203E-04
693.15	57.9625	30.838	3.6010E-04
693.15	80.7927	34.693	4.7126E-04
713.15	36.4349	13.877	9.8968E-05
713.15	38.5050	15.860	1.2297E-04
713.15	41.3027	18.503	1.5897E-04
713.15	43.7353	20.559	1.8598E-04
713.15	47.4781	23.129	2.2499E-04
713.15	51.5615	25.231	2.7002E-04
713.15	58.3532	27.754	3.3007E-04
713.15	70.9060	30.838	4.2018E-04
733.15	40.7098	13.877	1.1997E-04
733.15	43.4862	15.860	1.4697E-04
733.15	47.2835	18.503	1.8898E-04
733.15	50.5772	20.559	2.2499E-04
733.15	55.5495	23.129	2.7602E-04
733.15	60.7813	25.231	3.2407E-04
733.15	69.1498	27.754	3.9615E-04
733.15	83.9788	30.838	4.9530E-04
753.15	44.9514	13.877	1.4097E-04
753.15	48.4549	15.860	1.7697E-04
753.15	53.2860	18.503	2.2499E-04
753.15	57.4668	20.559	2.7002E-04

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
753.15	63.6913	23.129	3.3307E-04
753.15	70.0847	25.231	3.9014E-04
753.15	80.0410	27.754	4.7426E-04
773.15	49.1580	13.877	1.6497E-04
773.15	53.4043	15.860	2.0999E-04
773.15	59.2948	18.503	2.7002E-04
773.15	64.3815	20.559	3.1806E-04
773.15	71.8765	23.129	3.9014E-04
773.15	79.4439	25.231	4.6525E-04
773.15	90.9985	27.754	5.5541E-04

**Reference:** Kennedy, G.C., Wasserburg, G.J., Heard, H.C.  
and Newton, R.C., 1962, The upper three phase  
53 region in the system SiO<sub>2</sub>-H<sub>2</sub>O: American  
Journal of Science, v. 260, p. 501-521

*Units of original measurements: Temperature in degrees C,  
Pressure in kbar, Solubility in wt%*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
1321.15	800.0000	40.261	1.1100E-01
1323.15	800.0000	40.221	1.0028E-01
1326.15	800.0000	40.161	1.0629E-01
1326.15	900.0000	42.154	2.0938E-01
1326.15	950.0000	43.064	2.8441E-01
1326.15	950.0000	43.064	3.2108E-01
1326.15	950.0000	43.064	3.2663E-01
1327.15	600.0000	35.225	6.2146E-02
1327.15	900.0000	42.135	2.1406E-01
1328.15	950.0000	43.026	2.3712E-01
1329.15	600.0000	35.182	4.9132E-02
1331.15	600.0000	35.140	6.5311E-02
1333.15	900.0000	42.020	1.4165E-01
1334.15	800.0000	40.002	1.0769E-01
1334.15	800.0000	40.002	8.0924E-02
1334.15	800.0000	40.002	8.7797E-02
1334.15	800.0000	40.002	1.0489E-01
1334.15	800.0000	40.002	1.0028E-01
1339.15	700.0000	37.617	8.3052E-02
1341.15	600.0000	34.928	7.2176E-02
1342.15	500.0000	31.789	4.3973E-02
1353.15	400.0000	27.802	3.2588E-02
1353.15	400.0000	27.802	3.1203E-02
1353.15	400.0000	27.802	3.0858E-02
1353.15	400.0000	27.802	3.1548E-02
1353.15	400.0000	27.802	3.5734E-02
1354.15	400.0000	27.781	3.3981E-02
1359.15	300.0000	22.991	2.4068E-02
1382.15	200.0000	16.500	1.7801E-02



**Reference:** Morey, G.W., Fournier, R.O., and Rowe, J.J., 1962, The solubility of quartz in water in the temperature interval from 25 to 300 C: *Geochimica et Cosmochimica Acta*, v. 26, p. 1029-1043

54

Units of original measurements: Temperature in degrees C, Pressure in atm, Solubility in ppm

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
318.15	101.3250	57.185	6.2966E-06
318.15	101.3250	57.185	5.6969E-06
318.15	101.3250	57.185	5.6969E-06
348.15	101.3250	56.346	1.0794E-05
348.15	101.3250	56.346	1.1394E-05
363.15	101.3250	55.864	1.7091E-05
363.15	101.3250	55.864	1.5892E-05
373.15	101.3250	55.522	2.0689E-05
373.15	101.3250	55.522	1.9790E-05
373.15	101.3250	55.522	2.0390E-05
378.15	101.3250	55.346	2.4288E-05
383.15	101.3250	55.165	2.6987E-05
389.15	101.3250	54.943	3.1785E-05
393.15	101.3250	54.792	3.4184E-05
393.15	101.3250	54.792	3.3584E-05
393.15	101.3250	54.792	3.3284E-05
398.15	101.3250	54.600	3.5983E-05
398.15	101.3250	54.600	3.5983E-05
410.15	101.3250	54.125	4.4080E-05
410.15	101.3250	54.125	4.3180E-05
410.15	101.3250	54.125	4.2880E-05
418.15	101.3250	53.797	5.1877E-05
423.15	101.3250	53.588	5.3077E-05
433.15	101.3250	53.159	6.2374E-05
433.15	101.3250	53.159	6.2974E-05
433.15	101.3250	53.159	6.1475E-05
433.15	101.3250	53.159	6.1175E-05
443.15	101.3250	52.716	6.7773E-05
458.15	101.3250	52.028	7.8871E-05
463.15	101.3250	51.793	8.6369E-05
473.15	101.3250	51.311	9.8968E-05
473.15	101.3250	51.311	9.8368E-05
498.15	101.3250	50.051	1.3317E-04
519.15	101.3250	48.927	1.6737E-04
538.15	101.3250	47.858	2.0098E-04
543.15	101.3250	47.568	2.1899E-04
546.15	101.3250	47.393	2.3250E-04
570.15	101.3250	45.938	2.6702E-04
570.15	101.3250	45.938	2.6702E-04
573.15	101.3250	45.750	2.7602E-04
573.15	101.3250	45.750	2.7723E-04

**Reference:** Weill, D.F. and Fyfe, W.S., 1964, The solubility of quartz in H<sub>2</sub>O in the range 1000-4000 bars and 400-550 C: *Geochimica et Cosmochimica Acta*, v. 28, p. 1243-1255

55

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	100.0000	38.464	5.1032E-04
673.15	125.0000	40.255	5.2235E-04
673.15	125.0000	40.255	5.4038E-04
673.15	125.0000	40.255	5.5541E-04
673.15	125.0000	40.255	5.5241E-04
673.15	125.0000	40.255	5.6142E-04
673.15	125.0000	40.255	4.2018E-04
673.15	150.0000	41.701	6.2456E-04
673.15	175.0000	42.925	6.9675E-04
673.15	200.0000	43.992	7.4488E-04
673.15	225.0000	44.942	7.7497E-04
673.15	250.0000	45.800	8.0506E-04
673.15	275.0000	46.586	8.2312E-04
673.15	300.0000	47.312	8.2914E-04
673.15	325.0000	47.987	8.4419E-04
673.15	400.0000	49.780	8.7129E-04
723.15	100.0000	34.091	6.4862E-04
723.15	125.0000	36.548	7.8099E-04
723.15	150.0000	38.416	8.4419E-04
723.15	175.0000	39.936	9.4656E-04
723.15	200.0000	41.227	9.9475E-04
723.15	225.0000	42.353	1.0701E-03
723.15	250.0000	43.355	1.1303E-03
723.15	275.0000	44.261	1.1906E-03
723.15	300.0000	45.089	1.2660E-03
723.15	350.0000	46.562	1.3626E-03
723.15	400.0000	47.850	1.4893E-03
773.15	100.0000	29.324	7.2081E-04
773.15	150.0000	34.971	1.1183E-03
773.15	200.0000	38.380	1.3716E-03
773.15	250.0000	40.865	1.5195E-03
773.15	300.0000	42.841	1.7099E-03
773.15	350.0000	44.492	1.8429E-03
773.15	400.0000	45.917	2.0123E-03
823.15	100.0000	24.676	7.8099E-04
823.15	150.0000	31.497	1.3475E-03
823.15	200.0000	35.514	1.7129E-03
823.15	250.0000	38.368	1.9760E-03
823.15	300.0000	40.595	2.2303E-03
823.15	400.0000	43.997	2.6519E-03
898.15	100.0000	19.182	8.2914E-04
898.15	100.0000	19.182	8.2312E-04
898.15	100.0000	19.182	7.9904E-04
898.15	100.0000	19.182	7.7497E-04
898.15	100.0000	19.182	7.0577E-04
898.15	100.0000	19.182	5.7044E-04

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
898.15	100.0000	19.182	8.0506E-04
898.15	100.0000	19.182	8.0807E-04

**Reference:** Anderson, G.M. and Burnham, C.W., 1965, The solubility of quartz in supercritical water:  
56 American Journal of Science, v. 263, p. 494-511

*Units of original measurements: Temperature in degrees C, Pressure in kbar, Solubility in wt%*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
773.15	100.0000	29.324	7.2081E-04
773.15	150.0000	34.971	1.0821E-03
773.15	150.0000	34.971	1.0821E-03
773.15	200.0000	38.380	1.2329E-03
773.15	300.0000	42.841	1.6857E-03
773.15	400.0000	45.917	1.9881E-03
773.15	500.0000	48.309	2.2606E-03
773.15	600.0000	50.287	2.4425E-03
773.15	600.0000	50.287	2.4728E-03
773.15	750.0000	52.759	2.7764E-03
773.15	830.0000	53.906	2.7460E-03
773.15	860.0000	54.312	2.8979E-03
873.15	100.0000	20.772	7.8099E-04
873.15	150.0000	28.192	1.5648E-03
873.15	150.0000	28.192	1.5346E-03
873.15	150.0000	28.192	1.4139E-03
873.15	200.0000	32.714	2.1697E-03
873.15	300.0000	38.379	2.8979E-03
873.15	300.0000	38.379	3.0499E-03
873.15	400.0000	42.105	3.5065E-03
873.15	400.0000	42.105	3.5675E-03
873.15	400.0000	42.105	3.4761E-03
873.15	500.0000	44.909	4.1169E-03
873.15	500.0000	44.909	3.8115E-03
873.15	600.0000	47.176	4.4228E-03
873.15	600.0000	47.176	4.6065E-03
873.15	620.0000	47.583	4.6678E-03
873.15	740.0000	49.785	5.2814E-03
873.15	745.0000	49.869	4.9130E-03
973.15	150.0000	22.706	1.9276E-03
973.15	150.0000	22.706	1.9276E-03
973.15	200.0000	27.676	2.6853E-03
973.15	200.0000	27.676	3.0195E-03
973.15	290.0000	33.650	4.4840E-03
973.15	300.0000	34.172	4.7904E-03
973.15	400.0000	38.463	5.0051E-03
973.15	485.0000	41.225	6.8233E-03
973.15	500.0000	41.655	6.6686E-03
973.15	605.0000	44.316	8.0647E-03
973.15	750.0000	47.273	9.7518E-03
973.15	800.0000	48.158	9.9401E-03
973.15	880.0000	49.465	1.0947E-02

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
973.15	985.0000	51.014	1.2212E-02
1073.15	200.0000	23.687	4.0864E-03
1073.15	200.0000	23.687	4.1169E-03
1073.15	300.0000	30.461	7.0400E-03
1073.15	400.0000	35.110	9.0629E-03
1073.15	400.0000	35.110	9.3758E-03
1073.15	500.0000	38.609	1.1294E-02
1073.15	600.0000	41.399	1.3836E-02
1073.15	600.0000	41.399	1.3229E-02
1073.15	770.0000	45.134	1.6407E-02
1173.15	200.0000	20.676	5.2814E-03
1173.15	200.0000	20.676	4.9744E-03
1173.15	200.0000	20.676	5.1893E-03
1173.15	210.0000	21.465	5.5582E-03
1173.15	300.0000	27.354	9.8459E-03
1173.15	305.0000	27.629	1.0254E-02
1173.15	400.0000	32.137	1.3644E-02
1173.15	510.0000	36.148	1.9827E-02
1173.15	520.0000	36.466	1.7443E-02
1173.15	550.0000	37.383	1.8746E-02
1173.15	560.0000	37.676	1.5922E-02
1173.15	590.0000	38.524	2.0814E-02
1173.15	730.0000	41.943	2.9142E-02
1173.15	740.0000	42.159	2.5915E-02
1173.15	740.0000	42.159	2.3801E-02
1173.15	750.0000	42.372	2.7404E-02
1173.15	830.0000	43.974	2.6692E-02

**Reference:** Semenova, A.I. and Tsiklis, D.S., 1970, Solubility of silicon dioxide in steam at high pressures and temperatures: Russian Journal of Physical Chemistry, v. 44, n. 10, p. 1420-1422  
57

*Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in wt%, Original data in graphical format*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
873.15	96.9767	20.168	8.8902E-05
873.15	145.5385	27.683	3.4792E-04
873.15	165.3488	29.785	7.8361E-04
873.15	170.7692	30.297	7.6180E-04
873.15	173.2308	30.523	1.1328E-03
873.15	192.9231	32.176	8.9267E-04
873.15	196.0000	32.413	1.2857E-03
873.15	209.3023	33.384	1.2480E-03
873.15	209.5385	33.400	1.6686E-03
873.15	229.8461	34.731	1.5044E-03
873.15	232.9231	34.919	2.0960E-03
873.15	251.8605	36.012	1.7911E-03
873.15	259.5349	36.425	1.7552E-03
873.15	260.2326	36.462	2.1319E-03
873.15	260.6154	36.482	2.2496E-03
873.15	268.0000	36.863	2.1618E-03



<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
873.15	272.9231	37.111	2.0412E-03
873.15	300.0000	38.379	2.6412E-03
973.15	102.5581	16.070	5.9256E-06
973.15	124.6154	19.416	1.0864E-05
973.15	160.3077	23.877	6.6370E-04
973.15	177.9070	25.687	1.7791E-03
973.15	195.3846	27.284	1.9425E-03
973.15	196.7442	27.400	2.1319E-03
973.15	223.0769	29.484	2.4473E-03
973.15	238.6046	30.576	3.0014E-03
973.15	250.7692	31.372	3.3502E-03
973.15	272.0930	32.660	3.4767E-03
973.15	301.3954	34.243	3.7720E-03
1073.15	115.1163	14.750	5.9256E-06
1073.15	141.8461	17.958	5.2209E-04
1073.15	144.3077	18.236	7.0730E-04
1073.15	145.8140	18.405	1.0574E-03
1073.15	166.0465	20.550	1.0871E-03
1073.15	214.8837	24.900	2.3595E-03
1073.15	230.4615	26.079	3.6815E-03
1073.15	252.0000	27.575	4.1129E-03
1073.15	253.2308	27.657	4.2569E-03
1073.15	258.8372	28.021	3.7117E-03
1073.15	305.5814	30.763	4.9450E-03
1073.15	327.2093	31.879	5.6556E-03
1173.15	172.3256	18.320	1.7970E-03
1173.15	186.2791	19.540	2.2636E-03
1173.15	216.2791	21.945	3.5008E-03
1173.15	245.5814	24.034	4.8420E-03

**Reference:** Crerar, D.A. and Anderson, G.M., 1971,  
58 Solubility and solvation reactions of quartz in  
dilute hydrothermal solutions: Chemical Geology,  
v. 8, p. 107-122

*Units of original measurements: Temperature in degrees C,  
Solubility in ppm of SiO<sub>2</sub>, all data points are at saturation*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
452.15	0.9799	49.295	5.1278E-05
452.15	0.9799	49.295	5.1877E-05
453.15	1.0028	49.236	4.8878E-05
454.15	1.0261	49.177	5.0318E-05
502.15	2.7462	45.986	1.2180E-04
543.15	5.5030	42.601	1.5537E-04
546.15	5.7659	42.321	1.6089E-04
546.15	5.7659	42.321	1.5483E-04
546.15	5.7659	42.321	1.5738E-04
546.15	5.7659	42.321	1.5099E-04
547.15	5.8556	42.226	1.5438E-04
548.15	5.9464	42.131	1.5039E-04
549.15	6.0382	42.036	1.5546E-04
549.15	6.0382	42.036	1.5372E-04

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
549.15	6.0382	42.036	1.5606E-04
549.15	6.0382	42.036	1.5861E-04
550.15	6.1312	41.939	1.5597E-04
550.15	6.1312	41.939	1.5588E-04
575.15	8.8325	39.299	1.8205E-04
578.15	9.2094	38.947	1.8217E-04
578.15	9.2094	38.947	1.8157E-04
594.15	11.4345	36.891	1.9225E-04
594.15	11.4345	36.891	1.8574E-04
596.15	11.7396	36.609	2.0287E-04
596.15	11.7396	36.609	1.8721E-04
596.15	11.7396	36.609	1.9123E-04
597.15	11.8945	36.466	1.9951E-04
599.15	12.2091	36.174	1.8931E-04
599.15	12.2091	36.174	1.8940E-04
602.15	12.6933	35.723	1.9222E-04
602.15	12.6933	35.723	1.8661E-04

**Reference:** Hemley, J.J., Montoya, J.W., Marinenko, J.W.  
and Luce, R.W., 1980, Equilibria in the system  
59 Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>-H<sub>2</sub>O and some general implications  
for alteration/mineralization processes:  
Economic Geology, v. 75, p. 210-228

*Units of original measurements: Temperature in degrees C,  
Pressure in kbar, Solubility in molality*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
473.15	1.5550	47.996	8.4510E-05
473.15	100.0000	51.275	9.7031E-05
473.15	200.0000	53.643	1.0639E-04
523.15	3.9760	44.345	1.3706E-04
523.15	100.0000	48.662	1.6862E-04
523.15	200.0000	51.476	1.9811E-04
573.15	8.5880	39.530	2.0273E-04
573.15	100.0000	45.693	2.6724E-04
573.15	200.0000	49.136	3.2878E-04
623.15	16.5300	31.901	2.2746E-04
623.15	100.0000	42.316	3.9528E-04
623.15	200.0000	46.636	5.2108E-04
673.15	100.0000	38.464	5.4564E-04
673.15	200.0000	43.992	7.3605E-04
723.15	100.0000	34.091	6.8692E-04
723.15	200.0000	41.227	9.9291E-04
773.15	100.0000	29.324	8.4510E-04
773.15	200.0000	38.380	1.3706E-03

**Reference:** Ragnarsdottir, K. V. and Walther, J.V., 1983, Pressure sensitive "silica geothermometer" determined from quartz solubility experiments at 250 C: *Geochimica et Cosmochimica Acta*, v. 47, p. 941-946

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in molality

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
523.15	25.0000	45.568	1.3539E-04
523.15	25.0000	45.568	1.3415E-04
523.15	25.0000	45.568	1.3477E-04
523.15	50.0000	46.761	1.4845E-04
523.15	50.0000	46.761	1.4641E-04
523.15	100.0000	48.662	1.6352E-04
523.15	100.0000	48.662	1.6694E-04

**Reference:** Walther, J.V. and Orville, P.M., 1983, The extraction-quench technique for determination of the thermodynamic properties of solute complexes: application to quartz solubility in fluid mixtures: *American Mineralogist*, v. 68, p. 731-741

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in molality

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
623.15	100.0000	24.676	3.9762E-04
623.15	200.0000	46.636	5.5005E-04
673.15	100.0000	29.324	5.1572E-04
673.15	200.0000	43.992	7.3000E-04
673.15	200.0000	43.992	7.2665E-04
673.15	200.0000	43.992	7.3506E-04
698.15	200.0000	42.623	8.6152E-04
723.15	200.0000	41.227	1.0476E-03
723.15	200.0000	41.227	1.0097E-03
733.15	100.0000	33.159	7.1012E-04
748.15	200.0000	39.811	1.1302E-03
773.15	200.0000	38.380	1.2885E-03
773.15	200.0000	38.380	1.2505E-03
773.15	100.0000	38.464	7.3845E-04
798.15	200.0000	36.945	1.5066E-03
798.15	200.0000	36.945	1.4029E-03
798.15	200.0000	36.945	1.4825E-03
798.15	200.0000	36.945	1.4355E-03
823.15	200.0000	35.514	1.5847E-03
823.15	100.0000	42.316	7.9304E-04

**Reference:** Manning, C.E., 1994, The solubility of quartz in H<sub>2</sub>O in the lower crust and upper mantle: *Geochimica et Cosmochimica Acta*, v. 58, n. 22, p. 4831-4839

Units of original measurements: Temperature in degrees C, Pressure in kbar, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
773.15	500.0000	48.309	2.3546E-03

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
773.15	750.0000	52.759	2.6488E-03
773.15	1000.0000	56.060	3.0681E-03
773.15	1000.0000	56.060	3.1046E-03
773.15	1250.0000	58.730	3.2233E-03
773.15	1500.0000	60.994	3.8817E-03
773.15	1750.0000	62.971	4.1261E-03
773.15	2000.0000	64.733	4.0742E-03
773.15	2000.0000	64.733	4.1200E-03
873.15	500.0000	44.909	4.0894E-03
873.15	500.0000	44.909	3.8756E-03
873.15	500.0000	44.909	4.8241E-03
873.15	750.0000	49.952	6.1713E-03
873.15	1000.0000	53.582	6.0880E-03
873.15	1000.0000	53.582	6.4430E-03
873.15	1000.0000	53.582	7.6076E-03
873.15	1250.0000	56.470	7.3252E-03
873.15	1250.0000	56.470	7.1392E-03
873.15	1500.0000	58.892	7.7412E-03
873.15	1750.0000	60.991	8.1705E-03
873.15	2000.0000	62.851	8.7911E-03
888.15	750.0000	49.541	6.8666E-03
888.15	1000.0000	53.221	8.2203E-03
888.15	1250.0000	56.140	8.3668E-03
888.15	1500.0000	58.585	9.1129E-03
888.15	1750.0000	60.702	9.1536E-03
973.15	500.0000	41.655	7.6915E-03
973.15	700.0000	46.326	9.8962E-03
973.15	880.0000	49.465	1.1635E-02
973.15	880.0000	49.465	1.1433E-02
973.15	880.0000	49.465	1.1715E-02
973.15	880.0000	49.465	1.1724E-02
973.15	880.0000	49.465	1.0723E-02
973.15	880.0000	49.465	1.2069E-02
973.15	880.0000	49.465	1.0336E-02
973.15	880.0000	49.465	1.1098E-02
973.15	880.0000	49.465	1.0846E-02
973.15	880.0000	49.465	1.1778E-02
973.15	1200.0000	53.749	1.3484E-02
973.15	1500.0000	56.894	1.4954E-02
973.15	1750.0000	59.110	1.8678E-02
1073.15	500.0000	38.609	1.1775E-02
1073.15	500.0000	38.609	1.1854E-02
1073.15	500.0000	38.609	1.1661E-02
1073.15	650.0000	42.606	1.6248E-02
1073.15	750.0000	44.743	1.8100E-02
1073.15	750.0000	44.743	1.8355E-02
1073.15	1000.0000	48.991	2.1716E-02
1173.15	800.0000	43.393	3.1193E-02
1173.15	800.0000	43.393	3.1072E-02
1173.15	900.0000	45.245	3.7047E-02
1173.15	1000.0000	46.891	4.1305E-02



**Compound: Silica (SiO<sub>2</sub>)**

**Reference:** Heitmann, H.G., 1964, Solubility of silicic acid in water and steam and their influence on turbine silication: Chemiker-Ztg./Chem. Apparatur, v. 88, n. 22, p. 891-893

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
368.15	0.0294	0.010	3.5980E-09
371.15	0.0490	0.016	4.4975E-09
393.15	0.0981	0.030	5.9967E-09
396.15	0.0490	0.015	5.0972E-09
420.15	0.2942	0.087	1.2293E-08
423.15	0.0294	0.008	4.4975E-09
424.15	0.0490	0.014	5.3970E-09
438.15	0.0981	0.027	7.1960E-09
453.15	0.2942	0.080	1.4692E-08
473.15	0.0490	0.012	7.7957E-09
473.15	0.8826	0.236	3.8978E-08
476.15	0.5884	0.153	2.5486E-08
478.15	0.0981	0.025	1.0194E-08
488.15	1.3729	0.363	8.0955E-08
493.15	0.0294	0.007	7.7957E-09
493.15	1.8633	0.502	1.2893E-07
506.15	0.2942	0.071	2.0689E-08
516.15	3.4323	0.948	3.5081E-07
521.15	0.8826	0.210	6.2965E-08
523.15	1.3729	0.332	1.0494E-07
523.15	1.8633	0.461	1.5591E-07
525.15	0.0981	0.023	1.4992E-08
527.15	0.5884	0.137	3.7779E-08
533.15	0.0490	0.011	1.1993E-08
538.15	4.9033	1.364	7.4958E-07
553.15	3.4323	0.837	4.5275E-07
563.15	0.2942	0.063	3.7479E-08
565.15	0.0981	0.021	2.1288E-08
572.15	0.5884	0.126	5.6968E-08
572.15	0.8826	0.190	1.1394E-07
573.15	0.0294	0.006	1.4992E-08
573.15	1.3729	0.298	1.7690E-07
573.15	1.8633	0.410	2.5186E-07
591.15	0.0490	0.010	2.0689E-08
603.15	0.2942	0.059	5.0972E-08
603.15	4.9033	1.098	1.1094E-06
604.15	3.4323	0.737	6.7463E-07
622.15	1.8633	0.373	4.4076E-07
623.15	0.5884	0.115	1.1094E-07
623.15	1.3729	0.272	3.2082E-07
626.15	0.0981	0.019	4.1377E-08
627.15	0.8826	0.172	2.2488E-07
638.15	0.0294	0.006	2.4886E-08
643.15	0.0981	0.018	5.0672E-08

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
647.15	3.4323	0.675	1.0134E-06
648.15	4.9033	0.988	1.5891E-06
652.15	0.0490	0.009	3.3581E-08
662.15	0.2942	0.054	9.1449E-08
672.15	4.9033	0.942	2.0089E-06
673.15	0.5884	0.106	1.8590E-07
673.15	0.8826	0.160	3.4781E-07
673.15	1.3729	0.250	5.2471E-07
673.15	1.8633	0.341	7.2560E-07
678.15	3.4323	0.637	1.3912E-06
706.15	0.0981	0.017	8.4553E-08
713.15	0.0490	0.008	5.6968E-08
718.15	0.2942	0.049	1.5831E-07
722.15	0.8826	0.148	5.6968E-07
722.15	1.3729	0.232	8.7851E-07
723.15	0.5884	0.098	3.0583E-07
723.15	1.8633	0.316	1.3403E-06
723.15	3.4323	0.591	2.1438E-06
731.15	4.9033	0.847	3.7180E-06
758.15	0.0981	0.016	1.3133E-07
772.15	0.5884	0.092	4.8873E-07
773.15	1.8633	0.294	2.2488E-06
773.15	3.4323	0.548	3.9578E-06
774.15	1.3729	0.216	1.5112E-06
774.15	4.9033	0.792	5.7869E-06
776.15	0.8826	0.138	9.1749E-07
783.15	0.2942	0.045	3.1483E-07
799.15	4.9033	0.763	7.2561E-06
818.15	0.0981	0.014	1.9849E-07
823.15	0.5884	0.086	7.4359E-07
823.15	0.8826	0.130	1.3553E-06
823.15	1.3729	0.202	2.3327E-06
824.15	1.8633	0.275	3.5081E-06
824.15	3.4323	0.511	5.9368E-06
853.15	0.2942	0.042	4.6774E-07
860.15	0.0981	0.014	2.5636E-07
870.15	1.3729	0.191	3.0973E-06
870.15	4.9033	0.694	1.3103E-05
873.15	0.5884	0.081	9.6547E-07
873.15	0.8826	0.122	1.8110E-06
873.15	3.4323	0.480	8.6054E-06
874.15	1.8633	0.259	5.2471E-06
911.15	1.8633	0.248	6.3566E-06
913.15	3.4323	0.458	1.0614E-05

**Compound: Sodium Chloride (NaCl)**

**Reference:** Spillner, F., 1940, High pressure steam as a solvent: Die Chemische Fabrik, v. 13, n. 22, p. 405-416  
01

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg, Data set excluded from equation fit

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
677.15	22.5553	6.828	1.2642E-04
678.15	14.7100	3.380	1.0173E-05
679.15	12.2583	2.652	5.5487E-06
679.15	22.0650	6.418	1.1717E-04
680.15	7.3550	1.446	2.4661E-06
680.15	9.8066	2.014	3.0826E-06
680.15	9.8066	2.014	2.1578E-06
680.15	26.9683	10.296	3.8257E-04
681.15	16.6713	3.984	1.7571E-05
681.15	19.6133	5.124	4.3160E-05
681.15	24.5166	7.879	1.7578E-04

**Reference:** Galobardes, J.F., Van Hare, D.R. and Rogers, L.B., 1981, Solubility of sodium chloride in dry steam: Journal of Chemical and Engineering Data, v. 26, p. 363-366  
02

Units of original measurements: Temperature in degrees C, Pressure in MPa, Solubility in ppb of Na

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	5.3900	1.041	6.4257E-08
673.15	6.2900	1.233	1.2224E-07
673.15	6.8900	1.365	1.6143E-07
673.15	7.2000	1.434	2.0531E-07
673.15	7.7600	1.561	2.2803E-07
673.15	8.6200	1.762	3.2990E-07
673.15	9.4800	1.970	4.8898E-07
673.15	10.3400	2.186	7.2093E-07
698.15	5.6100	1.036	8.7766E-08
698.15	6.5600	1.227	1.5046E-07
698.15	7.5200	1.427	1.9277E-07
723.15	1.3800	0.233	8.6198E-10
723.15	1.8100	0.307	9.4035E-10
723.15	2.2400	0.381	3.6047E-09
723.15	2.6700	0.456	5.0152E-09
723.15	3.1000	0.532	7.8362E-09
723.15	3.4500	0.595	1.4105E-08
723.15	4.3100	0.750	2.8210E-08
723.15	5.1700	0.908	5.4854E-08
723.15	5.8400	1.034	9.0900E-08
723.15	6.0300	1.070	8.7766E-08
723.15	6.8200	1.221	1.9042E-07
723.15	6.8900	1.235	1.5672E-07
723.15	7.7600	1.406	2.1550E-07
723.15	7.8200	1.417	2.5233E-07

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	8.6200	1.578	3.7222E-07
723.15	9.4800	1.755	5.3286E-07
723.15	10.3400	1.936	7.6795E-07
748.15	6.0600	1.030	9.5602E-08
748.15	7.0900	1.218	1.8493E-07
748.15	8.1300	1.412	3.3774E-07
773.15	6.2800	1.028	1.5672E-07
773.15	6.8900	1.133	2.0531E-07
773.15	7.3600	1.216	2.5154E-07
773.15	7.7600	1.286	2.6800E-07
773.15	8.4400	1.408	3.3931E-07
773.15	8.6200	1.440	3.7849E-07
773.15	9.4800	1.596	5.8458E-07
773.15	10.3400	1.755	7.3269E-07
798.15	6.5000	1.025	1.9355E-07
798.15	7.6200	1.212	2.2882E-07
798.15	8.7500	1.404	3.4088E-07
823.15	6.7200	1.024	2.1315E-07
823.15	6.8900	1.051	2.2647E-07
823.15	7.7600	1.190	3.3696E-07
823.15	7.8900	1.211	3.3852E-07
823.15	8.6200	1.330	4.2237E-07
823.15	10.3400	1.614	8.7296E-07

**Reference:** Alekhin, Yu.V. and Vakulenko, A.G., 1988, Thermodynamic parameters and solubility of NaCl in water vapor at 300-500 C up to 300 bar.: Geochemistry International, v. 25, n. 5, p. 97-110  
04

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in mole fraction, Data set excluded from equation fit

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
583.15	3.5740	0.809	1.3760E-06
583.15	4.7660	1.122	3.3800E-06
583.15	6.1550	1.527	7.0800E-06
583.15	6.7200	1.708	9.9080E-06
603.15	2.6290	0.555	1.1350E-06
603.15	4.9980	1.122	3.9700E-06
603.15	6.4950	1.527	8.0000E-06
603.15	7.7240	1.897	1.5700E-05
603.15	8.6800	2.215	2.3660E-05
623.15	3.8550	0.802	3.2600E-06
623.15	5.1850	1.113	4.7400E-06
623.15	6.7750	1.514	9.0800E-06
623.15	8.1000	1.881	1.8150E-05
623.15	10.6100	2.686	3.8550E-05
623.15	10.6500	2.700	3.8900E-05
673.15	2.9530	0.549	5.5400E-06
673.15	4.2250	0.801	7.2000E-06
673.15	5.7220	1.111	9.7200E-06
673.15	7.5450	1.512	1.4250E-05
673.15	9.1050	1.878	2.4310E-05



Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	12.1860	2.682	6.0000E-05
673.15	15.5000	3.711	1.2300E-04
673.15	17.2600	4.358	1.7300E-04
723.15	3.1920	0.549	1.0770E-05
723.15	4.5850	0.800	1.2740E-05
723.15	6.2390	1.110	1.6150E-05
723.15	8.2810	1.510	2.1230E-05
723.15	13.6500	2.678	8.3080E-05
723.15	17.6900	3.703	1.8500E-04
723.15	21.7700	4.916	3.4520E-04
723.15	25.1000	6.087	5.0700E-04
773.15	3.4280	0.548	2.0300E-05
773.15	4.9390	0.799	2.3600E-05
773.15	8.9940	1.508	3.8770E-05
773.15	10.9700	1.873	4.8190E-05
773.15	15.0400	2.673	1.2250E-04
773.15	19.7600	3.697	2.5020E-04
773.15	24.7400	4.914	5.0350E-04
773.15	32.3800	7.129	1.0450E-03

**Reference:** Armellini, F.J. and Tester, J.W., 1993, Solubility of sodium chloride and sulfate in sub- and supercritical water vapor from 450 - 550 C and 100 - 250 bar: Fluid Phase Equilibria, v. 84, p. 123-142

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in ppm

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	10.0000	1.864	4.6239E-07
723.15	15.0000	3.004	3.8532E-06
723.15	20.0000	4.363	1.9606E-05
773.15	10.0000	1.692	2.7743E-07
773.15	15.0000	2.665	4.2232E-06
773.15	20.0000	3.752	9.6795E-06
773.15	25.0000	4.982	3.1136E-05
823.15	10.0000	1.557	2.7743E-07
823.15	20.0000	3.350	1.0419E-05
823.15	25.0000	4.358	3.0211E-05

**Reference:** Sourirajan, S. and Kennedy, G.C., 1962, The system H<sub>2</sub>O-NaCl at elevated temperatures and pressures: American Journal of Science, v. 260, p. 115-141

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in wt%, Data set excluded from equation fit

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
623.15	10.0000	2.474	6.1652E-06
623.15	11.4000	2.981	8.0148E-06
673.15	10.0000	2.100	1.2947E-05
673.15	15.0000	3.542	2.1271E-05
673.15	18.2000	4.743	2.4662E-05

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	10.0000	1.864	2.0654E-05
723.15	15.0000	3.004	3.3603E-05
723.15	20.0000	4.363	4.1310E-05
723.15	25.0000	6.049	4.5935E-05
723.15	25.9000	6.399	4.8402E-05
773.15	5.0000	0.809	6.7817E-06
773.15	10.0000	1.692	2.7745E-05
773.15	15.0000	2.665	4.3160E-05
773.15	20.0000	3.752	5.5493E-05
773.15	25.0000	4.982	6.4435E-05
773.15	30.0000	6.387	7.2144E-05
773.15	33.0000	7.331	7.4919E-05
823.15	5.0000	0.753	1.1098E-05
823.15	10.0000	1.557	3.3603E-05
823.15	15.0000	2.419	5.0560E-05
823.15	20.0000	3.350	6.2585E-05
823.15	25.0000	4.358	7.3994E-05
823.15	30.0000	5.455	8.5095E-05
823.15	35.0000	6.649	9.6814E-05
823.15	37.9000	7.389	1.0576E-04
873.15	5.0000	0.705	1.9729E-05
873.15	10.0000	1.446	3.8227E-05
873.15	15.0000	2.227	5.6726E-05
873.15	20.0000	3.052	6.9369E-05
873.15	25.0000	3.926	7.8928E-05
873.15	30.0000	4.850	9.0338E-05
873.15	35.0000	5.829	1.0298E-04
873.15	38.0000	6.442	1.1624E-04
873.15	39.2000	6.693	1.2765E-04
898.15	5.0000	0.684	2.8361E-05
898.15	10.0000	1.398	4.4702E-05
898.15	15.0000	2.145	6.1660E-05
898.15	20.0000	2.929	7.8619E-05
898.15	25.0000	3.751	9.8356E-05
898.15	30.0000	4.614	1.1779E-04
898.15	35.0000	5.519	1.4554E-04
898.15	37.9000	6.063	2.2946E-04
923.15	2.0000	0.262	2.3120E-05
923.15	5.0000	0.664	3.4527E-05
923.15	10.0000	1.353	5.4876E-05
923.15	15.0000	2.071	8.0161E-05
923.15	20.0000	2.818	1.1593E-04
923.15	25.0000	3.597	1.6251E-04
923.15	30.0000	4.409	2.1959E-04
923.15	35.6000	5.357	4.9376E-04
948.15	2.0000	0.255	3.7919E-05
948.15	5.0000	0.645	6.5668E-05
948.15	10.0000	1.312	1.0853E-04
948.15	15.0000	2.003	1.6961E-04
948.15	20.0000	2.718	2.5322E-04
948.15	25.0000	3.460	3.7022E-04

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
948.15	30.0000	4.228	6.6312E-04
948.15	32.6000	4.638	1.1791E-03
973.15	2.0000	0.249	8.0161E-05
973.15	5.0000	0.627	1.6374E-04
973.15	10.0000	1.273	3.1032E-04
973.15	15.0000	1.939	5.4165E-04
973.15	20.0000	2.627	9.2793E-04
973.15	25.2000	3.364	1.5733E-03
973.15	28.7000	3.874	2.9216E-03
998.15	2.0000	0.242	2.7946E-04
998.15	5.0000	0.610	6.3344E-04
998.15	10.0000	1.237	1.4253E-03
998.15	15.0000	1.881	2.7945E-03
998.15	20.0000	2.542	5.6929E-03
1023.15	2.0000	0.236	3.9872E-03
1023.15	5.0000	0.595	6.7435E-03
1023.15	7.5000	0.897	1.0107E-02
1023.15	10.0000	1.203	1.4403E-02
1023.15	13.0000	1.575	2.2727E-02

**Reference:** Olander, A. and Liander, H., 1950, The phase diagram of sodium chloride and steam above the critical point: Acta Chemica Scandinavica, v. 4, p. 1437-1445

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
653.15	15.2003	3.966	1.8496E-05
663.15	16.5732	4.310	2.4662E-05
673.15	17.9462	4.636	3.0828E-05
683.15	19.4172	4.984	4.0077E-05
693.15	20.8882	5.311	4.9327E-05
703.15	22.2611	5.576	6.1660E-05
713.15	23.8302	5.901	8.0161E-05
723.15	25.3012	6.164	1.0175E-04
733.15	26.7722	6.409	1.2025E-04
748.15	29.1258	6.794	1.5727E-04

**Reference:** Styrikovich, M.A., Khaibullin, I.Kh. and Tschvirashvili, D.G., 1955, Solubility of salts in high pressure steam: Dokl. Akad. Nauk SSSR, v. 100, p. 1123-1126

Units of original measurements: Temperature in degrees C, Pressure in atm, Solubility in mg/kg, Original data in graphical format

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
673.15	3.0398	0.566	1.3133E-07
673.30	10.1325	2.132	1.4447E-06
673.45	14.1855	3.274	6.0226E-06
673.60	14.1855	3.272	5.5536E-06
674.81	3.0398	0.565	3.0957E-07
674.96	3.0398	0.565	3.9400E-07

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
694.86	15.4014	3.387	5.0376E-06
696.07	15.4014	3.373	5.8256E-06
696.82	15.4014	3.364	5.0939E-06
696.82	18.2385	4.245	1.3143E-05
697.57	18.2385	4.232	1.5066E-05
699.23	18.2385	4.203	1.3106E-05
701.49	14.1855	2.981	3.4616E-06
703.45	14.1855	2.963	3.7805E-06
703.60	14.1855	2.962	3.3302E-06
720.79	18.2385	3.884	9.1372E-06
720.94	14.1855	2.822	2.8612E-06
721.69	18.2385	3.873	8.8745E-06
723.20	3.0398	0.522	5.9100E-07
723.80	18.2385	3.846	8.9965E-06
724.26	14.1855	2.797	2.7674E-06
724.41	15.4014	3.093	4.0057E-06
724.86	18.2385	3.833	9.0809E-06
725.16	10.1325	1.884	9.8500E-07
725.31	3.0398	0.520	6.5666E-07
725.91	14.1855	2.786	2.9925E-06
726.07	18.2385	3.818	8.9777E-06
726.22	3.0398	0.519	4.1276E-07
726.67	15.4014	3.074	4.0244E-06
745.21	18.2385	3.606	7.5142E-06
746.42	14.1855	2.650	2.5235E-06
747.02	18.2385	3.588	7.5518E-06
748.68	14.1855	2.636	2.5141E-06
766.32	14.1855	2.535	2.5516E-06
766.77	18.2385	3.407	7.2140E-06
768.73	18.2385	3.391	7.2328E-06
769.33	3.0398	0.487	4.4090E-07
769.48	14.1855	2.519	2.5516E-06
770.54	18.2385	3.376	7.2516E-06
771.44	10.1325	1.722	1.2946E-06
771.74	18.2385	3.366	6.9983E-06
772.04	3.0398	0.485	9.5685E-07
772.35	14.1855	2.504	2.8331E-06
772.35	18.2385	3.361	7.0921E-06
773.25	14.1855	2.499	2.7299E-06
791.19	14.1855	2.411	2.8893E-06
791.19	18.2385	3.219	7.1296E-06
817.57	18.2385	3.047	7.6362E-06
818.93	3.0398	0.455	2.2420E-06
820.29	18.2385	3.030	7.6174E-06
820.44	10.1325	1.586	1.8011E-06
820.44	14.1855	2.285	3.9869E-06
820.74	10.1325	1.585	2.7768E-06
821.19	14.1855	2.282	3.8181E-06
821.49	18.2385	3.023	7.5049E-06
822.85	3.0398	0.453	1.8199E-06
823.00	18.2385	3.014	7.5518E-06



Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
823.15	18.2385	3.014	7.6831E-06
824.05	10.1325	1.577	2.3452E-06
824.36	10.1325	1.576	2.0169E-06
824.36	10.1325	1.576	2.5329E-06
824.51	14.1855	2.269	3.8274E-06
826.01	3.0398	0.451	2.5235E-06
826.01	3.0398	0.451	2.3734E-06

**Reference:** Aleinikov, G.I., et. al., 1956, Solubility of sodium chloride in a superheated vapor ...:  
09 Teploenergetika, v. 3, n. 12, p. 10-14

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg, Original data in graphical format

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
633.15	10.7873	2.635	2.5653E-06
639.20	10.7873	2.573	2.6498E-06
641.31	10.7873	2.553	2.8714E-06
642.23	10.7873	2.544	2.4808E-06
644.19	10.7873	2.526	2.1958E-06
644.19	10.7873	2.526	1.7524E-06
648.27	10.7873	2.490	2.0691E-06
649.40	10.7873	2.480	2.4175E-06
650.46	10.7873	2.471	1.4991E-06
650.46	10.7873	2.471	2.0163E-06
653.48	10.7873	2.446	1.6469E-06
653.48	10.7873	2.446	1.5307E-06
653.55	10.7873	2.446	1.7947E-06
655.52	10.7873	2.430	1.8580E-06
655.52	10.7873	2.430	1.3935E-06
655.59	10.7873	2.429	1.4991E-06
659.46	10.7873	2.399	1.3618E-06
659.53	10.7873	2.399	1.7208E-06
660.65	10.7873	2.390	1.4252E-06
661.64	10.7873	2.383	1.5096E-06
662.55	10.7873	2.376	1.3196E-06
662.70	10.7873	2.375	1.6363E-06
663.61	10.7873	2.368	1.3513E-06
663.68	10.7873	2.368	1.4674E-06
664.66	10.7873	2.361	1.3407E-06
664.74	10.7873	2.360	1.4991E-06
665.65	10.7873	2.354	1.3724E-06
665.79	10.7873	2.353	1.4674E-06
666.71	10.7873	2.346	1.6257E-06
668.89	10.7873	2.331	1.1296E-06
671.84	10.7873	2.311	1.5096E-06
674.94	10.7873	2.291	1.2035E-06
675.92	10.7873	2.284	1.0346E-06
678.95	10.7873	2.265	1.0557E-06
680.00	10.7873	2.258	9.9234E-07
681.06	10.7873	2.252	1.1718E-06

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
686.12	10.7873	2.221	1.1929E-06
687.18	10.7873	2.215	9.0788E-07
687.25	10.7873	2.215	1.1718E-06
690.48	10.7873	2.196	1.2563E-06
691.40	10.7873	2.191	8.2343E-07
692.31	10.7873	2.186	9.0788E-07
692.45	10.7873	2.185	1.2351E-06
692.87	10.7873	2.183	8.9732E-07
694.28	10.7873	2.175	9.5011E-07
694.35	10.7873	2.175	8.5510E-07
695.48	10.7873	2.168	9.0788E-07

**Reference:** Styrikovich, M.A., 1957, Solubility of salts in steam of supercritical characteristics:  
10 Teploenergetika, v. 4, n. 2, p. 3-7

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg, Original data in graphical format

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
661.47	21.5746	7.314	6.3524E-05
673.95	23.5360	7.770	8.4442E-05
693.29	21.5746	5.596	3.4444E-05
694.01	21.5746	5.573	3.6233E-05
694.55	23.5360	6.459	5.9162E-05
695.46	25.4973	7.472	9.9544E-05
697.45	23.5360	6.334	5.6142E-05
699.25	27.4586	8.419	1.7138E-04
701.24	25.4973	7.139	8.4106E-05
702.14	17.6520	3.969	1.2524E-05
703.41	25.4973	7.027	8.4330E-05
707.93	17.6520	3.886	1.0959E-05
714.44	25.4973	6.546	5.4688E-05
721.67	19.1230	4.126	1.3755E-05
722.57	23.5360	5.528	3.6345E-05
724.02	19.1230	4.093	1.3755E-05
726.01	19.1230	4.066	1.4873E-05
726.19	19.1230	4.063	1.1742E-05
726.91	25.4973	6.124	5.6142E-05
728.36	23.5360	5.388	3.4108E-05
730.52	25.4973	6.018	5.1220E-05
731.97	23.5360	5.307	2.9970E-05
731.97	27.4586	6.711	8.6679E-05
734.86	21.5746	4.643	1.8563E-05
747.52	23.5360	5.001	2.5497E-05
750.23	27.4586	6.161	5.7148E-05
750.41	29.4200	6.827	7.7394E-05
753.84	27.4586	6.070	5.2786E-05
754.02	29.4200	6.716	7.7394E-05
757.28	25.4973	5.394	3.6010E-05
759.63	21.5746	4.284	1.5656E-05
765.59	21.5746	4.210	1.5208E-05



<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)	<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
773.55	17.6520	3.223	7.1567E-06	637.15	9.9047	2.317	8.6312E-07
774.27	23.5360	4.590	2.1695E-05	637.15	10.1008	2.377	8.9395E-07
780.05	27.4586	5.520	4.7753E-05	637.15	10.4931	2.499	7.0899E-07
780.78	29.4200	6.046	6.5537E-05	637.15	10.7873	2.593	1.4180E-06
783.13	21.5746	4.015	1.5208E-05	637.15	10.9834	2.658	9.8642E-07
783.13	27.4586	5.465	4.2497E-05	637.15	11.3757	2.789	9.2477E-07
784.94	29.4200	5.961	6.1063E-05	637.15	11.5719	2.856	2.0653E-06
786.02	19.1230	3.444	1.1183E-05	646.15	6.0801	1.260	4.7472E-07
787.47	21.5746	3.971	1.4537E-05	646.15	7.5511	1.617	2.9593E-07
787.47	29.4200	5.910	6.4531E-05	646.15	7.6492	1.641	4.0690E-07
788.37	27.4586	5.377	4.5404E-05	646.15	8.5318	1.869	5.1171E-07
788.91	25.4973	4.876	3.0977E-05	646.15	9.0221	2.001	5.1171E-07
791.08	25.4973	4.847	2.9635E-05	646.15	9.4144	2.109	4.6855E-07
794.15	23.5360	4.346	2.2589E-05	646.15	9.5124	2.136	7.7064E-07
798.67	23.5360	4.297	2.2589E-05	646.15	10.0028	2.276	7.3982E-07
800.48	19.1230	3.334	1.1183E-05	646.15	10.2970	2.362	6.1651E-07
805.90	23.5360	4.220	2.2701E-05	646.15	10.3950	2.391	1.1097E-06
807.71	25.4973	4.636	2.7174E-05	646.15	10.9834	2.569	1.4796E-06
808.62	23.5360	4.193	2.2701E-05	646.15	11.2777	2.660	1.1406E-06
810.42	17.6520	2.977	7.3804E-06	646.15	11.7680	2.818	1.5721E-06
815.12	21.5746	3.722	1.7333E-05	646.15	11.8661	2.850	1.9112E-06
820.91	29.4200	5.355	5.0773E-05	646.15	11.9641	2.883	2.2503E-06
822.90	29.4200	5.327	5.0773E-05	646.15	12.5525	3.083	2.7743E-06
826.87	27.4586	4.841	3.6793E-05	646.15	12.5525	3.083	2.0962E-06
827.96	25.4973	4.414	2.5497E-05	646.15	12.7487	3.152	2.4969E-06
829.22	27.4586	4.814	3.6793E-05	646.15	13.3370	3.365	4.3156E-06
830.13	25.4973	4.392	2.7845E-05	646.15	13.3370	3.365	3.0518E-06
834.47	19.1230	3.112	1.1406E-05	675.15	3.5304	0.660	4.0073E-07
834.83	21.5746	3.571	1.6774E-05	675.15	4.7072	0.896	2.1578E-07
836.63	23.5360	3.937	2.3484E-05	675.15	5.8840	1.141	3.6991E-07
839.35	17.6520	2.818	7.9395E-06	675.15	6.9627	1.375	3.0826E-07
843.14	27.4586	4.660	4.0819E-05	675.15	8.0414	1.618	5.5486E-07
843.87	21.5746	3.508	1.8004E-05	675.15	8.6298	1.755	4.9321E-07
843.87	29.4200	5.056	5.3457E-05	675.15	8.7279	1.779	3.6991E-07
845.67	27.4586	4.634	4.0931E-05	675.15	9.6105	1.992	4.6239E-07
847.30	23.5360	3.852	2.4714E-05	675.15	9.6105	1.992	5.8569E-07
848.38	19.1230	3.033	1.4202E-05	675.15	10.1008	2.114	1.2947E-06
848.57	29.4200	5.001	5.3793E-05	675.15	10.1989	2.138	9.2477E-07
852.36	25.4973	4.185	3.1760E-05	675.15	10.2970	2.163	7.0899E-07
				675.15	10.4931	2.213	5.5486E-07
				675.15	10.8854	2.315	9.5560E-07
				675.15	11.0815	2.366	9.2477E-07
				675.15	11.0815	2.366	7.3982E-07
				675.15	11.2777	2.418	1.2947E-06
				675.15	11.7680	2.550	1.1714E-06
				675.15	12.0622	2.631	1.1097E-06
				675.15	12.1603	2.658	1.8495E-06
				675.15	12.2583	2.685	2.1578E-06
				675.15	12.3564	2.713	1.8495E-06
				675.15	12.6506	2.796	1.3872E-06
				675.15	12.9448	2.881	1.5413E-06

**Reference:** Sastry, V., 1957, Die Löslichkeit von Salzen in Hochgespanntem Wasserdampf und die  
 // Klärung der Frage der Turbinenversalzung:  
 Doctoral Dissertation - Technische Hochschule  
 Karlsruhe

*Units of original measurements: Temperature in degrees C,  
 Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
637.15	8.2376	1.839	4.2848E-07
637.15	8.9240	2.029	6.1651E-07
637.15	9.3163	2.142	7.7064E-07
637.15	9.7086	2.258	1.1097E-06

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)	<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
675.15	13.1409	2.938	1.9112E-06	759.15	16.0829	2.984	4.4081E-06
675.15	13.2390	2.967	2.4661E-06	759.15	16.2790	3.027	5.0863E-06
675.15	13.4351	3.025	2.1578E-06	759.15	16.9655	3.181	5.3329E-06
675.15	13.4351	3.025	3.0826E-06	759.15	17.1616	3.225	5.7336E-06
675.15	13.7293	3.113	4.1615E-06	759.15	17.2597	3.248	5.1479E-06
675.15	13.9254	3.173	2.1578E-06	759.15	17.9462	3.405	6.6893E-06
675.15	14.1216	3.234	3.0826E-06	759.15	18.1423	3.451	6.8434E-06
675.15	14.2196	3.264	2.8360E-06	759.15	18.4365	3.520	6.4118E-06
675.15	14.6119	3.388	2.9593E-06	759.15	18.6326	3.566	8.0148E-06
675.15	14.6119	3.388	4.6239E-06	759.15	19.1230	3.682	1.0913E-05
675.15	15.1022	3.547	4.3156E-06	759.15	19.2210	3.706	8.9088E-06
675.15	15.1022	3.547	4.2540E-06	759.15	19.6133	3.801	7.5524E-06
675.15	15.2003	3.580	5.7336E-06	759.15	19.6133	3.801	1.0173E-05
675.15	15.3964	3.645	4.9630E-06	759.15	20.2017	3.944	1.2331E-05
675.15	15.5926	3.712	4.0074E-06	759.15	20.2998	3.969	1.3286E-05
675.15	15.5926	3.712	7.3366E-06	759.15	20.4959	4.017	1.4797E-05
675.15	15.7887	3.779	6.7817E-06	759.15	20.7901	4.091	1.1252E-05
675.15	15.7887	3.779	7.3983E-06	759.15	21.3785	4.240	1.5413E-05
675.15	15.8868	3.813	5.8570E-06	759.15	21.4766	4.265	1.9976E-05
675.15	15.8868	3.813	6.0111E-06	759.15	21.9669	4.391	1.3872E-05
675.15	16.1810	3.916	1.0573E-05	759.15	21.9669	4.391	2.2658E-05
675.15	16.1810	3.916	8.6314E-06	759.15	22.4572	4.519	2.3722E-05
675.15	16.2790	3.951	5.5487E-06	759.15	22.6534	4.571	2.0038E-05
675.15	16.3771	3.986	6.1652E-06	759.15	23.0456	4.676	1.8959E-05
675.15	16.4752	4.022	9.1862E-06	759.15	23.1437	4.702	2.7806E-05
675.15	16.5732	4.057	8.9396E-06	759.15	23.6340	4.835	3.5144E-05
675.15	16.6713	4.093	1.3718E-05	759.15	23.8302	4.888	2.5278E-05
675.15	16.7694	4.130	8.3231E-06	759.15	24.2224	4.997	2.2812E-05
675.15	16.7694	4.130	1.4489E-05	759.15	24.5166	5.079	3.8566E-05
675.15	16.8674	4.166	1.3564E-05	759.15	24.9089	5.189	3.6069E-05
675.15	17.1616	4.277	1.1406E-05	759.15	25.1050	5.245	3.6840E-05
675.15	17.2597	4.315	8.0148E-06	759.15	25.3012	5.302	3.5761E-05
759.15	8.0414	1.369	3.8532E-07	759.15	26.0857	5.530	5.6649E-05
759.15	8.0414	1.369	4.0073E-07	759.15	26.3799	5.617	4.8247E-05
759.15	8.8260	1.514	7.0899E-07	820.15	6.4724	0.989	4.4697E-07
759.15	9.3163	1.606	6.7817E-07	820.15	6.8647	1.051	3.3600E-07
759.15	9.3163	1.606	6.1651E-07	820.15	7.5511	1.162	2.7743E-07
759.15	9.5124	1.643	3.3908E-07	820.15	8.1395	1.257	3.2367E-07
759.15	10.1989	1.774	8.3229E-07	820.15	9.0221	1.402	4.0073E-07
759.15	10.3950	1.811	1.1714E-06	820.15	10.0028	1.565	8.6312E-07
759.15	11.4738	2.022	1.3872E-06	820.15	10.4931	1.647	7.0899E-07
759.15	12.6506	2.258	1.7571E-06	820.15	10.5912	1.663	8.0147E-07
759.15	12.9448	2.318	1.9420E-06	820.15	11.4738	1.813	1.0172E-06
759.15	13.7293	2.479	2.1270E-06	820.15	11.9641	1.897	1.7879E-06
759.15	14.0235	2.541	2.9285E-06	820.15	12.0622	1.914	1.6646E-06
759.15	14.0235	2.541	2.9901E-06	820.15	12.4545	1.982	1.4796E-06
759.15	14.3177	2.603	2.6818E-06	820.15	12.8467	2.050	1.5105E-06
759.15	14.9061	2.728	3.7608E-06	820.15	13.4351	2.153	2.9593E-06
759.15	15.1022	2.770	3.0826E-06	820.15	13.6312	2.188	1.8804E-06
759.15	15.3964	2.834	4.0999E-06	820.15	14.2196	2.292	2.4661E-06
759.15	15.7887	2.919	3.9457E-06	820.15	14.4158	2.327	2.4352E-06



<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
820.15	14.5138	2.345	2.4969E-06
820.15	15.3964	2.504	2.2503E-06
820.15	15.5926	2.540	3.2367E-06
820.15	15.6906	2.557	2.8976E-06
820.15	15.8868	2.593	3.3600E-06
820.15	16.6713	2.737	4.3156E-06
820.15	16.7694	2.756	4.6856E-06
820.15	16.9655	2.792	4.1923E-06
820.15	17.1616	2.829	4.7472E-06
820.15	17.7500	2.939	5.6412E-06
820.15	18.3384	3.050	6.1652E-06
820.15	18.5346	3.088	5.0246E-06
820.15	18.8288	3.144	5.8261E-06
820.15	18.8288	3.144	6.2577E-06
820.15	19.6133	3.295	8.3847E-06
820.15	19.9075	3.352	7.3366E-06
820.15	20.0056	3.371	9.4945E-06
820.15	20.7901	3.526	1.0974E-05
820.15	21.0843	3.584	1.0789E-05
820.15	21.7708	3.721	9.9261E-06
820.15	22.3592	3.840	1.3101E-05
820.15	22.4572	3.860	1.5937E-05
820.15	23.4379	4.061	1.5968E-05
820.15	23.6340	4.102	1.5937E-05
820.15	25.1050	4.411	2.0500E-05
820.15	26.2818	4.665	2.3891E-05
867.15	9.1202	1.324	6.4734E-07
867.15	10.1008	1.474	7.0899E-07
867.15	12.5525	1.856	1.7571E-06
867.15	13.4351	1.996	1.9420E-06
867.15	13.7293	2.043	2.0345E-06
867.15	14.6119	2.185	2.2195E-06
867.15	15.7887	2.377	2.4352E-06
867.15	15.8868	2.393	3.1442E-06
867.15	16.8674	2.555	3.9149E-06
867.15	17.0636	2.587	3.7608E-06
867.15	18.1423	2.768	4.8089E-06
867.15	18.2404	2.784	5.1479E-06
867.15	19.4172	2.984	6.4735E-06
867.15	19.4172	2.984	6.5351E-06
867.15	20.4959	3.170	8.0765E-06
867.15	20.4959	3.170	7.6141E-06
867.15	21.7708	3.392	8.8163E-06
867.15	21.8688	3.409	1.0851E-05
867.15	23.1437	3.636	1.1930E-05
867.15	23.4379	3.688	1.2146E-05
867.15	24.5166	3.883	1.7109E-05
867.15	25.0070	3.972	1.8804E-05

**Reference:** Martynova, O.I. and Samoilov, Yu.F., 1962, The formation of solutions of inorganic substances in water vapour: Russian Journal of Inorganic Chemistry, v. 7, n. 4, p. 372-375

*Units of original measurements: Temperature in degrees C, Pressure in atm, Solubility in mg/kg*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
610.15	10.1325	2.671	7.4598E-07
722.15	14.1855	2.813	3.3292E-06
725.15	14.1855	2.791	3.6683E-06
771.15	14.1855	2.510	3.2059E-06
771.15	14.1855	2.510	3.5142E-06
772.15	7.3967	1.224	6.7200E-07
773.15	14.1855	2.500	3.0826E-06
773.15	18.2385	3.355	6.7509E-06
773.15	18.2385	3.355	7.0900E-06
773.15	18.2385	3.355	6.7509E-06
773.15	18.2385	3.355	6.9975E-06
773.15	18.2385	3.355	6.7509E-06
773.15	18.2385	3.355	6.7817E-06
774.15	14.1855	2.494	3.0826E-06
775.15	7.3967	1.218	7.0283E-07
775.15	14.1855	2.489	3.1442E-06
778.15	14.1855	2.474	3.2367E-06
784.15	10.1325	1.683	1.2639E-06
812.15	18.2385	3.080	7.8607E-06
813.15	18.2385	3.074	8.0148E-06
823.15	10.1325	1.579	2.3119E-06
823.15	18.2385	3.014	8.1690E-06
825.15	14.1855	2.267	3.1689E-06
830.15	14.1855	2.247	4.7780E-06

**Reference:** Bell, M.J., Mravich, N.J., Pocock, F.J. and Rubright, M.M., 1977, Solids behavior in once-through nuclear steam systems: Proceedings of the American Power Conference, v. 39, p. 849-867

*Units of original measurements: Temperature in degrees F, Pressure in psia, Solubility in ppb of Na*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
573.71	6.3776	1.656	2.9778E-08
598.71	7.3291	1.802	2.8210E-07
599.82	7.3429	1.799	2.7505E-07
600.93	8.1082	2.039	5.3286E-07

**Reference:** Allmon, W.E., et. al., 1983, Deposition of corrosive salts from steam: Electric Power Research Institute Research Project 1068-1 (NP-3002)

*Units of original measurements: Temperature in degrees F, Pressure in psia, Solubility in wt%*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
499.26	2.3787	0.650	2.1886E-09

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
510.37	2.9992	0.822	3.6991E-09
515.93	3.2750	0.895	6.7816E-09
517.59	3.5163	0.971	4.3156E-09
519.82	3.6542	1.010	6.7816E-09
523.15	3.2750	0.872	2.6510E-09
524.26	3.7576	1.027	1.2639E-08
525.37	3.3440	0.887	5.8569E-09
534.26	3.9645	1.056	6.4734E-09
535.37	4.5505	1.251	1.8804E-08
544.26	4.5850	1.218	1.1097E-08

**Reference:** Bischoff, J.L., Rosenbauer, R.J. and Pitzer, K.S., 1986, The system NaCl-H<sub>2</sub>O: relations of vapor-liquid near the critical temperature of water and of vapor-liquid-halite from 300 to 500 C: *Geochimica et Cosmochimica Acta*, v. 50, p. 1437-1444

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
596.85	7.8800	1.995	2.1886E-06
621.65	10.5300	2.675	4.3156E-06
648.25	13.7400	3.483	9.8644E-06
648.65	13.8400	3.514	8.0148E-06
673.35	17.2700	4.358	2.0038E-05
700.15	21.4100	5.323	4.0077E-05
723.65	25.1500	6.091	8.3245E-05
724.95	25.3500	6.127	9.5580E-05
749.05	28.8800	6.679	1.4184E-04
750.15	29.1900	6.754	1.5110E-04
775.65	32.7200	7.164	2.1588E-04
776.55	32.8000	7.163	2.3131E-04

**Reference:** Wofford, W.T., Dell'Orco, P.C. and Gloyna, E.F., 1995, Solubility of potassium hydroxide and potassium phosphate in supercritical water: *Journal of Chemical and Engineering Data*, v. 40, p. 968-973

Units of original measurements: Temperature in degrees C, Pressure in MPa, Solubility in mg/kg

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	24.8000	5.973	7.1835E-05
743.15	25.0000	5.534	6.0118E-05

**Reference:** Baierlein, H., 1983, Zur Loslichkeit von Salzen in uberkritischem Wasserdampf: Doctoral Dissertation - Erlangen

Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in Wt%, Data set excluded from equation fit

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
721.15	17.5000	3.674	1.5105E-05

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
721.15	24.2000	5.807	7.7077E-05
723.15	18.7000	3.984	7.3983E-06
723.15	22.4000	5.123	4.3777E-05
723.15	25.4000	6.203	8.3245E-05

**Reference:** Urusova, M.A., 1974, Phase equilibria in the sodium hydroxide-water and sodium chloride-water systems at 350-550 C: *Russian Journal of Inorganic Chemistry*, v. 19, n. 3, p. 450-454

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mole %

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	41.3841	16.179	9.4000E-03
723.15	42.0705	16.742	1.6000E-02
723.15	42.1686	16.822	2.4000E-02
723.15	42.2667	16.901	2.4000E-02
773.15	57.5650	17.751	2.6000E-02
773.15	58.0554	17.966	3.3000E-02
773.15	58.3496	18.095	4.0000E-02
823.15	74.0402	18.434	4.2000E-02
823.15	74.5305	18.577	5.2000E-02
823.15	74.6286	18.605	5.2000E-02



## Compound: Sodium Hydroxide (NaOH)

**Reference:** Sastry, V., 1957, Die Loslichkeit von Salzen in Hochgespanntem Wasserdampf und die Klärung der Frage der Turbinenversalzung: Doctoral Dissertation - Technische Hochschule Karlsruhe

11

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
675.15	5.9821	1.162	3.2430E-07
675.15	7.0608	1.397	4.5492E-07
675.15	7.9434	1.596	4.9546E-07
675.15	8.5318	1.732	6.8013E-07
675.15	8.8260	1.802	2.0719E-07
675.15	9.6105	1.992	6.9364E-07
675.15	10.2970	2.163	1.4864E-06
675.15	10.3950	2.188	1.0810E-06
675.15	11.1796	2.392	9.9091E-07
675.15	12.1603	2.658	1.3963E-06
675.15	12.2583	2.685	1.6215E-06
675.15	12.8467	2.852	2.6124E-06
675.15	13.0428	2.909	2.1170E-06
675.15	13.8274	3.143	2.7926E-06
675.15	14.0235	3.203	3.7835E-06
675.15	14.7100	3.419	4.4591E-06
675.15	15.4945	3.678	6.3509E-06
675.15	15.6906	3.745	5.4050E-06
675.15	16.1810	3.916	4.5492E-06
675.15	16.2790	3.951	8.6931E-06
675.15	16.6713	4.093	6.7563E-06

**Reference:** Bell, M.J., Mravich, N.J., Pocock, F.J. and Rubright, M.M., 1977, Solids behavior in once-through nuclear steam systems: Proceedings of the American Power Conference, v. 39, p. 849-867

13

Units of original measurements: Temperature in degrees F, Pressure in psia, Solubility in ppb of Na

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
535.37	1.1859	0.277	7.8362E-09
535.37	1.3376	0.314	1.8807E-08
535.37	1.5720	0.373	1.4105E-08
547.04	0.9239	0.209	4.7017E-09
575.93	6.5155	1.688	1.5281E-07
589.82	7.2533	1.839	4.2316E-07
600.37	7.3222	1.789	5.8772E-07
602.59	7.3567	1.786	5.8772E-07

**Reference:** Allmon, W.E., et. al., 1983, Deposition of corrosive salts from steam: Electric Power Research Institute Research Project 1068-1 (NP-3002)

14

Units of original measurements: Temperature in degrees F, Pressure in psia, Solubility in wt%

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
403.15	0.1586	0.048	4.5041E-10
404.82	0.1586	0.048	1.8017E-10
464.82	0.3654	0.097	2.4322E-10
470.37	0.9997	0.271	7.2066E-10
470.93	1.4479	0.406	3.0628E-09
471.48	1.0204	0.277	7.2066E-10
472.59	1.0135	0.274	9.4587E-10
473.15	0.9928	0.267	6.3058E-10
474.26	1.0204	0.274	1.5765E-09
495.37	1.9374	0.520	1.0179E-08
497.04	2.4132	0.666	7.9273E-09
497.04	2.4476	0.677	5.4050E-09
504.26	2.6200	0.715	7.6570E-09
507.04	2.3787	0.633	2.8827E-09
510.37	0.9859	0.242	7.6570E-10
511.48	2.7096	0.725	4.0087E-09
511.48	2.7510	0.738	3.6934E-09
512.59	2.0753	0.534	2.2521E-09
512.59	2.0822	0.536	2.2521E-09
514.82	0.9997	0.243	6.3058E-10
517.04	0.9515	0.230	7.6570E-10
517.04	1.0066	0.243	7.6570E-10
517.04	1.7306	0.432	8.5579E-10
519.26	1.7857	0.445	1.9368E-09
519.82	1.7857	0.444	2.1169E-09
520.37	1.7788	0.441	2.2070E-09
522.04	3.6197	0.989	1.2927E-08
527.04	3.4680	0.921	1.1756E-08
555.93	5.5158	1.474	1.2522E-08
572.04	4.5160	1.089	6.2608E-08
573.71	2.8268	0.640	3.0628E-09
573.71	4.9504	1.207	7.9723E-08
574.82	1.7030	0.372	1.5765E-09

**Reference:** Urusova, M.A., 1974, Phase equilibria in the sodium hydroxide-water and sodium chloride-water systems at 350-550 C: Russian Journal of Inorganic Chemistry, v. 19, n. 3, p. 450-454

63

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mole %

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
723.15	44.5222	18.680	2.3000E-02
723.15	44.5222	18.680	2.4000E-02
723.15	44.7183	18.829	2.3000E-02
723.15	44.8164	18.902	2.3000E-02
723.15	45.8951	19.692	3.2000E-02

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
773.15	63.9394	20.390	3.8000E-02
773.15	64.3316	20.540	3.8000E-02
773.15	65.9007	21.124	4.7000E-02
773.15	67.1756	21.580	6.0000E-02

# **Compound: Sodium Phosphate (Na<sub>3</sub>PO<sub>4</sub>)**

**Reference:** Wetton, E.A.M., 1981, Phase equilibria in aqueous sodium phosphate solutions at 350 C: Power Industry Research, v. 1, p. 151-158  
27

*Units of original measurements: Temperature in degrees C, Solubility in wt%, Original data in graphical format, all data points are at saturation*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
623.15	16.5294	31.901	5.9690E-04

**Reference:** Schroeder, W.C., Berk, A.A. and Gabriel, A., 1937, Solubility equilibria of sodium sulfate at temperatures from 150 to 350 degrees. III. Effect of sodium hydroxide and sodium phosphate: Journal of the American Chemical Society, v. 59, p. 1783-1790  
28

*Units of original measurements: Temperature in degrees C, Solubility in wt%, all data points are at saturation*

<i>Temperature</i> (K)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Solubility</i> (mole fraction)
487.15	2.0650	47.059	5.2083E-02
487.15	2.0650	47.059	5.2872E-02
489.15	2.1473	46.921	5.0896E-02
489.15	2.1473	46.921	4.9707E-02
498.15	2.5497	46.280	2.6946E-02
498.15	2.5497	46.280	2.9644E-02
498.15	2.5497	46.280	2.9126E-02
498.15	2.5497	46.280	3.5710E-02
508.15	3.0625	45.535	1.9291E-02
523.15	3.9762	44.345	9.2541E-03
523.15	3.9762	44.345	9.3620E-03
523.15	3.9762	44.345	9.3620E-03
573.15	8.5879	39.530	2.6304E-03
623.15	16.5294	31.901	1.6481E-04

**Compound: Sodium Sulfate (Na<sub>2</sub>SO<sub>4</sub>)**

**Reference:** Armellini, F.J. and Tester, J.W., 1993, Solubility of sodium chloride and sulfate in sub- and supercritical water vapor from 450 - 550 C and 100 - 250 bar: Fluid Phase Equilibria, v. 84, p. 123-142

*Units of original measurements: Temperature in degrees C, Pressure in bar, Solubility in ppm*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
773.15	25.0000	4.982	1.2049E-07

**Reference:** Styrikovich, M.A., Khaibullin, I.Kh. and Tschvirashvili, D.G., 1955, Solubility of salts in high pressure steam: Dokl. Akad. Nauk SSSR, v. 100, p. 1123-1126

*Units of original measurements: Temperature in degrees C, Pressure in atm, Solubility in mg/kg, Original data in graphical format*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
601.08	10.1325	2.803	1.9358E-09
623.36	14.1855	4.296	2.5766E-09
627.02	10.1325	2.479	1.6688E-09
640.10	3.0398	0.601	2.5766E-09
642.92	14.1855	3.760	1.6688E-09
643.02	18.2385	6.070	1.0053E-08
643.23	10.1325	2.336	2.1761E-09
654.74	18.2385	5.395	5.5939E-09
655.58	20.2650	6.735	1.8263E-08
661.02	3.0398	0.579	1.8958E-09
661.64	10.1325	2.204	2.4298E-09
662.59	14.1855	3.420	2.9505E-09
681.73	14.1855	3.177	4.3256E-09
683.30	20.2650	5.344	8.0103E-09
683.40	10.1325	2.076	4.8195E-09
684.03	3.0398	0.556	3.8716E-09
703.38	18.2385	4.135	5.5271E-09
705.05	14.1855	2.949	6.0878E-09
705.05	20.2650	4.780	6.5150E-09
705.79	10.1325	1.966	5.1666E-09
706.73	3.0398	0.535	5.5405E-09
709.97	18.2385	4.033	5.5271E-09
729.53	3.0398	0.516	7.3027E-09
732.36	10.1325	1.856	8.2106E-09
732.77	20.2650	4.295	8.8514E-09
733.61	14.1855	2.732	7.4896E-09
733.72	18.2385	3.728	7.8367E-09
765.93	18.2385	3.414	8.7846E-09
766.14	3.0398	0.489	9.8927E-09
766.14	10.1325	1.738	1.1882E-08
786.96	3.0398	0.475	1.4245E-08
790.51	14.1855	2.414	1.3204E-08
790.51	18.2385	3.223	1.3711E-08
791.14	10.1325	1.663	1.4192E-08

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
815.30	18.2385	3.060	1.5700E-08
815.72	3.0398	0.457	1.7262E-08
816.35	14.1855	2.302	1.6568E-08
816.98	10.1325	1.594	1.6661E-08

**Reference:** Styrikovich, M.A., 1957, Solubility of salts in steam of supercritical characteristics: Teploenergetika, v. 4, n. 2, p. 3-7

*Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg, Original data in graphical format*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
668.15	27.4586	16.433	5.0098E-07
675.53	25.4973	9.416	2.9223E-08
675.53	25.4973	9.416	1.8235E-08
678.57	25.4973	8.979	2.5132E-08
680.43	23.5360	7.246	1.1689E-08
681.60	23.5360	7.166	1.1339E-08
681.60	27.4586	10.602	3.8575E-08
681.83	23.5360	7.151	8.7670E-09
683.00	27.4586	10.339	6.5460E-08
684.17	29.4200	12.646	9.0242E-08
684.63	21.5746	5.909	7.7150E-09
685.10	29.4200	12.378	9.2931E-08
685.57	29.4200	12.251	4.7108E-08
686.27	21.5746	5.844	7.8319E-09
690.24	21.5746	5.699	8.8839E-09
699.57	29.4200	9.806	1.6365E-08
704.24	29.4200	9.310	1.1689E-08
707.51	27.4586	7.838	6.8967E-09
707.74	29.4200	8.993	6.0785E-09
709.85	25.4973	6.732	5.1433E-09
718.01	23.5360	5.647	1.9872E-09
718.25	23.5360	5.640	6.6629E-09
719.65	23.5360	5.603	2.2210E-09
722.68	23.5360	5.525	7.2474E-09
724.32	23.5360	5.484	2.6886E-09
727.35	21.5746	4.773	2.2210E-09
728.52	21.5746	4.752	8.2995E-09
731.32	21.5746	4.703	3.0392E-09
731.79	21.5746	4.695	4.2082E-09
732.49	21.5746	4.682	5.1433E-09
753.03	25.4973	5.478	2.9223E-09
760.03	23.5360	4.794	2.4548E-09
760.26	21.5746	4.276	5.4940E-09
760.50	21.5746	4.273	4.0913E-09
768.20	21.5746	4.179	4.4420E-09
769.84	25.4973	5.167	8.2995E-09
770.30	23.5360	4.644	3.1561E-09
776.61	27.4586	5.583	4.0913E-09
777.30	21.5746	4.077	1.9872E-09



Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
778.24	21.5746	4.067	4.6757E-09
783.61	27.4586	5.457	4.0913E-09
789.68	25.4973	4.866	1.2391E-08
790.38	23.5360	4.389	5.1433E-09
792.24	25.4973	4.831	1.5898E-08
793.88	25.4973	4.809	2.6886E-09
795.28	21.5746	3.896	1.9872E-09
795.51	23.5360	4.331	5.3771E-09
801.58	29.4200	5.654	4.6757E-09
802.05	29.4200	5.646	5.4940E-09
803.22	23.5360	4.248	4.4420E-09
804.62	27.4586	5.129	6.3123E-09
807.42	21.5746	3.787	2.2210E-09
810.45	25.4973	4.603	5.6109E-09
812.09	25.4973	4.585	6.5460E-09
815.82	21.5746	3.717	3.2730E-09
816.75	25.4973	4.532	5.6109E-09
820.49	23.5360	4.079	3.3899E-09
822.36	23.5360	4.061	2.8054E-09
841.50	21.5746	3.524	4.6757E-09
849.43	27.4586	4.596	5.8447E-09
852.24	25.4973	4.186	6.8967E-09
854.34	25.4973	4.168	6.3123E-09
854.57	27.4586	4.545	7.0136E-09
858.07	25.4973	4.136	6.8967E-09
863.21	29.4200	4.841	6.8967E-09
865.77	21.5746	3.366	7.9488E-09
866.71	23.5360	3.709	6.6629E-09
868.11	23.5360	3.699	7.4812E-09
869.27	21.5746	3.345	6.5460E-09
871.38	29.4200	4.758	7.8319E-09
898.92	25.4973	3.830	8.1826E-09
908.49	25.4973	3.768	7.9488E-09
929.50	2.9420	0.385	9.5853E-09
948.41	10.3950	1.365	9.3515E-09
950.04	2.9420	0.376	1.0871E-08
973.38	9.8066	1.248	1.6014E-08

**Reference:** Sastry, V., 1957, Die Löslichkeit von Salzen in Hochgespanntem Wasserdampf und die Klärung der Frage der Turbinenversalzung: Doctoral Dissertation - Technische Hochschule Karlsruhe

*Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
675.15	8.0414	1.618	4.0586E-08
675.15	9.2182	1.896	4.0586E-08
675.15	9.6105	1.992	4.9464E-08
675.15	10.1989	2.138	4.0586E-08
675.15	10.4931	2.213	4.5659E-08
675.15	11.2777	2.418	3.9317E-08

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
675.15	11.2777	2.418	3.5512E-08
675.15	12.1603	2.658	3.9317E-08
675.15	12.3564	2.713	2.5366E-08
675.15	12.9448	2.881	4.5659E-08
675.15	13.4351	3.025	3.6781E-08
675.15	13.6312	3.084	5.2000E-08
675.15	14.2196	3.264	4.0586E-08
675.15	14.4158	3.326	5.2000E-08
675.15	15.0042	3.515	5.3268E-08
675.15	15.2003	3.580	7.1025E-08
675.15	15.9848	3.847	9.0049E-08
675.15	15.9848	3.847	6.2147E-08
675.15	16.6713	4.093	1.1034E-07
675.15	16.7694	4.130	9.8927E-08

**Reference:** Morey, G.W. and Hesselgesser, J.M., 1951, The solubility of some minerals in superheated steam at high pressures: Economic Geology, v. 46, p. 821-835

*Units of original measurements: Temperature in degrees C, Pressure in psia, Solubility in wt%*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
773.15	6.7000	1.100	1.0883E-06
773.15	13.3000	2.323	4.7036E-06
773.15	66.6000	21.376	3.1579E-05
773.15	100.0000	29.324	5.4828E-04

**Reference:** Novikov, B.E., 1973, Investigation of thermodynamic properties and behavior of salts with common ions in boiler water at high temperatures: Dissertation - Moscow Power Institute

*Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in mg/kg*

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
486.65	1.8142	0.497	3.0693E-18
506.15	2.8243	0.777	8.7386E-17
519.15	3.4814	0.953	7.1659E-16
527.15	4.0207	1.105	2.5366E-15
535.15	4.6386	1.284	8.7766E-15
541.90	5.1975	1.449	2.4859E-14
555.65	6.5214	1.859	1.9785E-13
570.15	8.0905	2.371	1.6234E-12
582.65	9.7086	2.953	9.6391E-12
594.15	11.1796	3.488	4.6673E-11
599.15	11.8661	3.749	9.2078E-11
609.15	13.4351	4.409	3.8429E-10
617.65	15.2003	5.367	1.3190E-09
632.65	18.4365	7.636	1.9912E-08
640.65	20.4959	10.053	2.0039E-07



**Reference:** Ravich, M.I. and Borovaya, F.E., 1964, Phase equilibria in the sodium sulphate-water system at high temperatures and pressures: Russian Journal of Inorganic Chemistry, v. 9, n. 4, p. 520-532

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in wt%, \* indicates data point is at saturation

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
593.15	11.0815	37.029	1.7001E-02 *
593.15	29.4200	39.548	3.5514E-02
593.15	39.2266	40.507	4.5900E-02
593.15	71.5885	42.862	6.3927E-02
593.15	95.4187	44.169	7.2128E-02
593.15	121.9947	45.390	7.9469E-02
623.15	16.4752	31.901	3.2415E-03 *
623.15	27.3606	35.233	9.4560E-03
623.15	40.0111	37.295	2.0229E-02
623.15	50.7985	38.566	3.3571E-02
623.15	50.9946	38.586	3.4537E-02
623.15	55.1134	39.002	3.9530E-02
623.15	58.8399	39.354	4.4808E-02
623.15	66.1949	39.994	5.3910E-02
623.15	75.8054	40.742	6.1329E-02
623.15	97.2820	42.156	7.0716E-02
623.15	119.9353	43.391	7.9469E-02
643.15	20.9862	25.058	6.3693E-04 *
643.15	38.7363	34.346	6.6310E-03
643.15	48.5429	36.004	1.3139E-02
643.15	58.3496	37.269	2.2736E-02
643.15	68.6466	38.354	3.4537E-02
643.15	78.4532	39.236	5.0396E-02
653.15	29.4200	29.326	1.2795E-03
653.15	39.2266	32.816	3.5736E-03
653.15	49.0333	34.787	7.3275E-03
653.15	58.8399	36.222	1.3896E-02
653.15	78.4532	38.339	4.0044E-02
673.15	49.0333	31.845	2.5817E-03
673.15	58.8399	33.802	4.5790E-03
673.15	64.2336	34.648	6.6310E-03
673.15	69.3330	35.351	9.8166E-03
673.15	76.0015	36.165	1.3896E-02
673.15	78.4532	36.440	1.6213E-02
673.15	81.3952	36.755	2.1892E-02
673.15	88.5541	37.464	3.6501E-02
673.15	95.1245	38.055	5.3910E-02
673.15	98.4588	38.337	7.0716E-02
673.15	115.7185	39.640	8.6513E-02
703.15	98.5568	35.754	1.3896E-02
703.15	104.9312	36.381	2.1892E-02
703.15	106.8925	36.564	3.0733E-02
703.15	107.8732	36.654	4.0562E-02
703.15	108.3635	36.698	5.1553E-02

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
703.15	109.8345	36.830	6.3927E-02
703.15	110.3248	36.873	7.8261E-02
703.15	110.8152	36.916	8.8303E-02
723.15	78.4532	31.023	1.2795E-03
723.15	88.5541	32.624	2.8449E-03
723.15	106.8925	34.852	1.2016E-02
773.15	122.9754	32.378	2.5817E-03

**Reference:** Schroeder, W.C., Gabriel, A. and Partridge, E.P., 1935, Solubility equilibria of sodium sulfate at temperatures of 150 to 350 degrees. I. Effect of sodium hydroxide and sodium chloride: Journal of the American Chemical Society, v. 57, p. 1539-1546

Units of original measurements: Temperature in degrees C, Solubility in wt%, all data points are at saturation

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
413.15	0.3615	51.408	5.0346E-02
413.15	0.3615	51.408	5.0574E-02
423.15	0.4762	50.902	5.0689E-02
429.15	0.5578	50.586	5.1260E-02
433.15	0.6182	50.371	5.0574E-02
433.15	0.6182	50.371	5.1146E-02
443.15	0.7922	49.816	5.1374E-02
443.15	0.7922	49.816	5.1830E-02
453.15	1.0028	49.236	5.2058E-02
453.15	1.0028	49.236	5.2742E-02
453.15	1.0028	49.236	5.1716E-02
453.15	1.0028	49.236	5.2058E-02
463.15	1.2552	48.630	5.3083E-02
463.15	1.2552	48.630	5.3424E-02
463.15	1.2552	48.630	5.2742E-02
463.15	1.2552	48.630	5.2969E-02
477.15	1.6893	47.734	5.1716E-02
483.15	1.9077	47.333	5.3765E-02
483.15	1.9077	47.333	5.3992E-02
492.15	2.2756	46.710	5.3992E-02
492.15	2.2756	46.710	5.3878E-02
494.15	2.3643	46.568	5.4672E-02
494.15	2.3643	46.568	5.4219E-02
503.15	2.7971	45.912	5.5465E-02
503.15	2.7971	45.912	5.4559E-02
513.15	3.3469	45.149	5.5012E-02
514.15	3.4062	45.070	5.4786E-02
514.15	3.4062	45.070	5.4559E-02
523.15	3.9762	44.345	5.1716E-02
524.15	4.0438	44.263	5.3651E-02
524.15	4.0438	44.263	5.3424E-02
533.15	4.6923	43.498	5.0689E-02
533.15	4.6923	43.498	5.0117E-02
533.15	4.6923	43.498	4.9888E-02
543.15	5.5030	42.601	4.7017E-02

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
543.15	5.5030	42.601	4.9201E-02
552.15	6.3204	41.745	4.2620E-02
552.15	6.3204	41.745	4.3433E-02
554.15	6.5139	41.548	4.1689E-02
561.15	7.2274	40.837	3.8651E-02
572.15	8.4676	39.643	2.9540E-02
574.15	8.7096	39.415	3.1328E-02
574.15	8.7096	39.415	2.7745E-02
583.15	9.8651	38.338	2.2804E-02
593.15	11.2843	37.029	1.6220E-02
603.15	12.8581	35.568	9.1736E-03
613.15	14.6007	33.897	5.2986E-03
622.15	16.3276	32.121	3.0347E-03
623.15	16.5294	31.901	3.0347E-03

**Reference:** Booth, H.S. and Bidwell, R.M., 1950, Solubilities of salts in water at high temperatures: Journal of the American Chemical Society, v. 72, p. 2567-2575  
33

Units of original measurements: Temperature in degrees C, Solubility in wt%, \* indicates data point is at saturation

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
603.15	12.8581	35.568	7.6641E-03 *
627.15	17.3577	30.958	2.1233E-03 *
633.15	18.6660	29.286	1.1505E-03 *
655.15	12.7860	24.030	4.7973E-04

**Reference:** Khaibullin, I.Kh. and Novikov, B.E., 1973, A thermodynamic study of aqueous and steam solutions of sodium sulfate at high temperatures: Teplofizika Vysokikh Temperatur, v. 11, n. 2, p. 320-327  
34

Units of original measurements: Temperature in degrees C, Pressure in kgf/cm<sup>2</sup>, Solubility in wt%, all data points are at saturation

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
527.15	4.0207	44.012	5.1553E-02
541.95	5.1975	42.711	4.7004E-02
555.65	6.5214	41.398	4.0562E-02
570.15	8.0905	39.868	3.0733E-02
582.65	9.7086	38.400	2.1892E-02
594.15	11.1796	36.891	1.3896E-02
599.15	11.8661	36.174	1.0908E-02
609.15	13.4351	34.596	6.6310E-03
617.65	15.2003	33.050	3.9072E-03
632.65	18.4365	29.441	1.2795E-03
640.65	20.3978	26.426	6.3693E-04

**Reference:** Khaibullin, I.Kh. and Novikov, B.E., 1973, Gamma-ray examination of saturation parameters and thermophysical properties of multicomponent salt systems at high temperatures: Mater. Vses. Nauchno-Tekh. Soveshch. Teploobmennym Teplofiz. Svoistvam Morsk. Solonovatykh Vod Ikh Ispol'z, p. 339-350  
35

Units of original measurements: Temperature in degrees C, Solubility in mol/L, all data points are at saturation

Temperature (K)	Pressure (MPa)	Density (mol/L)	Solubility (mole fraction)
583.15	9.8651	38.338	2.3893E-02
593.15	11.2843	37.029	1.5717E-02
603.15	12.8581	35.568	9.8402E-03
613.15	14.6007	33.897	5.7232E-03
623.15	16.5294	31.901	2.9278E-03
633.15	18.6660	29.286	1.2668E-03



## APPENDIX B - VAPOR PRESSURES

The vapor pressure of a solute can provide a lower bound (though usually far too low for the systems and conditions of interest in this report) on its solubility. In addition, it may be a useful quantity in future modeling efforts. This appendix therefore discusses the vapor pressure of compounds of interest in this report, and tabulates them where appropriate.

Vapor pressures for pure condensed phases can be computed from the free energy functions given in thermochemical tables such as the JANAF [B1] compilation. In order to make this computation, there must be a table both for the condensed phase of interest and for the gas phase (the table is normally for the ideal gas at 0.1 MPa; computing the vapor pressure from these tables requires assuming ideality in the vapor phase which is generally a good assumption at these low pressures). For the compounds of interest in this study, the measured vapor pressures are almost always at higher temperatures than those of interest. Those measurements are used to tie the gas tables to those for the condensed phase at that particular temperature, but then the accuracy of a vapor pressure computation at a lower temperature depends on the accuracy of the heat capacities used to take the free energy function to lower temperatures. Fortunately, common salts and minerals are sufficiently well studied that extrapolation with heat capacity data does not introduce a great deal of error.

The following sections describe the individual condensed phases of interest.

### NaCl

Fairly consistent vapor pressure measurements exist down to 743 K. The JANAF tables allow calculations throughout our temperature range. A complication is the extensive dimerization in the vapor. The JANAF tables have separate ideal-gas tables for the monomer and dimer. These can be used to compute separate monomer and dimer vapor pressures. The points above 1073 K are for the vapor pressure above molten NaCl.

Table B-1. NaCl vapor pressures from the JANAF tables [B1].

T(K)	P <sup>monomer</sup> (MPa)	P <sup>dimer</sup> (MPa)
400	$1.62 \times 10^{-23}$	$9.32 \times 10^{-26}$
500	$1.41 \times 10^{-17}$	$3.70 \times 10^{-19}$
600	$1.20 \times 10^{-13}$	$8.33 \times 10^{-15}$
700	$7.30 \times 10^{-11}$	$9.86 \times 10^{-12}$
800	$8.57 \times 10^{-9}$	$1.86 \times 10^{-9}$
900	$3.37 \times 10^{-7}$	$1.03 \times 10^{-7}$
1000	$6.15 \times 10^{-6}$	$2.41 \times 10^{-6}$
1100	$5.96 \times 10^{-5}$	$2.61 \times 10^{-5}$
1200	$3.17 \times 10^{-4}$	$1.22 \times 10^{-4}$



## SiO<sub>2</sub>

Vapor pressure measurements are fairly consistent, but are all above 1600 K. The JANAF tables allow extrapolation to lower temperatures; the system has been studied enough that such extrapolation is probably fairly good. There has been some reexamination of the heat capacity data since the publication of the JANAF tables, but the differences are too small to worry about given the uncertainties in the vapor pressures.

Table B-2. SiO<sub>2</sub> vapor pressures from the JANAF tables [B1].

T(K)	P <sup>sat</sup> (MPa)
400	$5.38 \times 10^{-71}$
500	$3.36 \times 10^{-55}$
600	$1.10 \times 10^{-44}$
700	$3.46 \times 10^{-37}$
800	$1.41 \times 10^{-31}$
900	$3.16 \times 10^{-27}$
1000	$9.33 \times 10^{-24}$
1100	$6.37 \times 10^{-21}$
1200	$1.45 \times 10^{-18}$
1300	$1.42 \times 10^{-16}$
1400	$7.19 \times 10^{-15}$
1500	$2.14 \times 10^{-13}$

## Na<sub>2</sub>SO<sub>4</sub>

Scattered vapor pressure data exist at higher temperatures (above about 1100 K). These measurements are complicated by a dissociation reaction that is important at high temperatures (but relatively small compared to the uncertainty of the measurements in the region of interest here). These data are input to the JANAF compilation, which allows reasonable estimates of vapor pressure throughout the temperature range of interest here.

Following is a table of vapor pressures generated from the JANAF tables. All the points are for crystalline sodium sulfate.

Table B-3.  $\text{Na}_2\text{SO}_4$  vapor pressures from the JANAF tables [B1].

T(K)	$P^{\text{sat}}$ (MPa)
400	$1.99 \times 10^{-37}$
500	$1.55 \times 10^{-28}$
600	$1.11 \times 10^{-22}$
700	$1.51 \times 10^{-18}$
800	$1.75 \times 10^{-15}$
900	$3.93 \times 10^{-13}$
1000	$2.81 \times 10^{-11}$
1100	$8.75 \times 10^{-10}$

## NaOH

Old vapor pressure data exist at very high temperatures. The JANAF tables use these and other means to compile sufficient information for vapor pressure calculation. This information has been updated since the JANAF publication; calculations here are based on new tables from recent work [B2]. The results are again complicated by dimerization. There is also a solid-solid phase transition at 568 K and a solid-liquid transition at 594 K.

Table B-4. NaOH vapor pressures from Gurvich et al. [B2].

T(K)	$P^{\text{monomer}}$ (MPa)	$P^{\text{dimer}}$ (MPa)
400	$8.08 \times 10^{-24}$	$4.80 \times 10^{-22}$
500	$9.66 \times 10^{-18}$	$3.39 \times 10^{-16}$
568	$7.40 \times 10^{-15}$	$1.93 \times 10^{-13}$
594	$5.86 \times 10^{-14}$	$1.30 \times 10^{-12}$
600	$9.08 \times 10^{-14}$	$1.91 \times 10^{-12}$
700	$4.21 \times 10^{-11}$	$4.22 \times 10^{-10}$
800	$3.92 \times 10^{-9}$	$2.13 \times 10^{-8}$
900	$1.26 \times 10^{-7}$	$4.10 \times 10^{-7}$
1000	$1.95 \times 10^{-6}$	$4.06 \times 10^{-6}$
1100	$1.78 \times 10^{-5}$	$2.51 \times 10^{-5}$
1200	$1.09 \times 10^{-4}$	$1.09 \times 10^{-4}$

## $\text{Fe}_3\text{O}_4$ and $\text{Fe}_2\text{O}_3$

No information available.

## **Na<sub>3</sub>PO<sub>4</sub>**

No information available.

## **CuO**

Vapor pressure can be calculated from the JANAF tables. Their calculations are indirect, as no reliable vapor pressure measurements exist. It was not felt worthwhile to pursue it at this point.

## **Cu<sub>2</sub>O**

No information available.

## **References for Appendix B**

[B1] Chase, M.W., Davies, C.A., Downey, J.R., Frurip, D.J., McDonald, R.A., and Syverud, A.N., JANAF Thermochemical Tables, 3rd ed., *J. Phys. Chem. Ref. Data*, 14, Supplement 1 (1985).

[B2] Gurvich, L.V., Bergman, G.A., Gorokhov, L.N., Iorish, V.S., Leonidov, V.Ya., and Yungman, V.S., Thermodynamic Properties of Alkali Metal Hydroxides Part 1. Lithium and Sodium Hydroxides, *J. Phys. Chem. Ref. Data*, 25, 1211 (1996).

# APPENDIX C - VAPOR-LIQUID PARTITIONING FOR Na<sub>3</sub>PO<sub>4</sub> and Na<sub>2</sub>SO<sub>4</sub>

**Table C-1. Data of Goodstine [29] for partitioning of Na<sub>3</sub>PO<sub>4</sub> between water and steam.**

<i>Pressure</i> (psig)	<i>Concentration</i>		<i>Concentration</i>		<i>Concentration</i>		<i>Partition Coefficient</i> (-)
	<i>Water</i> (ppm of Na)	<i>Steam</i>	<i>Water</i> (ppm of Na <sub>3</sub> PO <sub>4</sub> )	<i>Steam</i>	<i>Water</i> (mole fraction of Na <sub>3</sub> PO <sub>4</sub> )	<i>Steam</i>	
3080	8.640E+00	9.297E-02	2.054E+01	2.210E-01	2.257E-06	2.428E-08	1.076E-02
3080	1.459E+01	1.999E-01	3.468E+01	4.751E-01	3.811E-06	5.221E-08	1.370E-02
3080	2.077E+01	3.330E-01	4.937E+01	7.915E-01	5.426E-06	8.698E-08	1.603E-02
3080	3.030E+01	4.512E-01	7.203E+01	1.072E+00	7.916E-06	1.179E-07	1.489E-02
3000	5.995E+00	2.111E-02	1.425E+01	5.018E-02	1.566E-06	5.515E-09	3.522E-03
3000	9.183E+00	5.513E-02	2.183E+01	1.311E-01	2.399E-06	1.440E-08	6.004E-03
3000	1.589E+01	8.964E-02	3.776E+01	2.131E-01	4.150E-06	2.341E-08	5.642E-03
3000	1.978E+01	1.322E-01	4.702E+01	3.143E-01	5.168E-06	3.454E-08	6.684E-03
3000	2.154E+01	1.405E-01	5.121E+01	3.340E-01	5.628E-06	3.671E-08	6.522E-03
3000	2.957E+01	1.626E-01	7.030E+01	3.865E-01	7.725E-06	4.247E-08	5.497E-03
3000	4.642E+01	4.350E-01	1.103E+02	1.034E+00	1.213E-05	1.136E-07	9.372E-03
3000	5.922E+01	7.336E-01	1.408E+02	1.744E+00	1.547E-05	1.916E-07	1.238E-02
3000	1.063E+02	1.267E+00	2.526E+02	3.013E+00	2.777E-05	3.310E-07	1.192E-02
3000	1.730E+02	2.086E+00	4.113E+02	4.958E+00	4.521E-05	5.448E-07	1.205E-02
3000	2.434E+02	3.115E+00	5.785E+02	7.403E+00	6.360E-05	8.136E-07	1.279E-02
2800	4.933E+00	3.021E-03	1.173E+01	7.182E-03	1.289E-06	7.892E-10	6.125E-04
2800	8.535E+00	3.670E-03	2.029E+01	8.723E-03	2.230E-06	9.586E-10	4.300E-04
2800	2.003E+01	1.987E-02	4.760E+01	4.723E-02	5.231E-06	5.190E-09	9.921E-04
2800	2.290E+01	2.271E-02	5.443E+01	5.398E-02	5.981E-06	5.932E-09	9.917E-04
2800	2.922E+01	3.310E-02	6.944E+01	7.867E-02	7.632E-06	8.645E-09	1.133E-03
2800	7.649E+01	1.770E-01	1.818E+02	4.208E-01	1.998E-05	4.624E-08	2.314E-03
2800	1.130E+02	2.775E-01	2.685E+02	6.596E-01	2.951E-05	7.249E-08	2.456E-03
2800	2.524E+02	7.073E-01	6.000E+02	1.681E+00	6.597E-05	1.848E-07	2.801E-03
2800	4.059E+02	1.558E+00	9.649E+02	3.704E+00	1.061E-04	4.070E-07	3.835E-03
2800	4.698E+02	1.676E+00	1.117E+03	3.984E+00	1.228E-04	4.378E-07	3.564E-03
2600	7.465E+00	1.422E-03	1.774E+01	3.381E-03	1.950E-06	3.716E-10	1.906E-04
2600	1.773E+01	3.453E-03	4.214E+01	8.209E-03	4.631E-06	9.021E-10	1.948E-04
2600	1.407E+01	3.806E-03	3.343E+01	9.047E-03	3.674E-06	9.942E-10	2.706E-04
2600	2.346E+01	9.468E-03	5.577E+01	2.251E-02	6.129E-06	2.473E-09	4.035E-04
2600	2.586E+01	1.136E-02	6.148E+01	2.700E-02	6.756E-06	2.968E-09	4.392E-04
2600	4.475E+01	2.692E-02	1.064E+02	6.399E-02	1.169E-05	7.032E-09	6.015E-04
2600	6.855E+01	5.513E-02	1.629E+02	1.311E-01	1.791E-05	1.440E-08	8.042E-04
2600	8.640E+01	8.036E-02	2.054E+02	1.910E-01	2.257E-05	2.099E-08	9.299E-04
2600	1.063E+02	6.779E-02	2.526E+02	1.611E-01	2.777E-05	1.771E-08	6.376E-04
2600	1.861E+02	2.124E-01	4.425E+02	5.049E-01	4.864E-05	5.548E-08	1.141E-03
2600	2.851E+02	3.625E-01	6.777E+02	8.618E-01	7.452E-05	9.470E-08	1.271E-03
2600	5.117E+02	6.737E-01	1.216E+03	1.601E+00	1.338E-04	1.760E-07	1.315E-03
2000	5.117E+01	1.858E-03	1.216E+02	4.417E-03	1.337E-05	4.854E-10	3.632E-05
2000	9.183E+01	6.188E-03	2.183E+02	1.471E-02	2.399E-05	1.616E-09	6.738E-05
2000	2.555E+02	2.503E-02	6.073E+02	5.949E-02	6.678E-05	6.537E-09	9.790E-05
2000	4.367E+02	8.036E-02	1.038E+03	1.910E-01	1.142E-04	2.099E-08	1.838E-04



Table C-2. Data of Goodstine [29] for partitioning of Na<sub>2</sub>SO<sub>4</sub> between water and steam.

Pressure (psig)	Concentration		Concentration		Concentration		Partition Coefficient (-)
	Water (ppm of Na)	Steam	Water (ppm of Na <sub>2</sub> SO <sub>4</sub> )	Steam	Water (mole fraction of Na <sub>2</sub> SO <sub>4</sub> )	Steam	
3000	7.676E+00	1.994E-02	2.371E+01	6.160E-02	3.008E-06	7.813E-09	2.598E-03
3000	8.159E+00	2.842E-02	2.521E+01	8.779E-02	3.197E-06	1.113E-08	3.483E-03
3000	1.848E+01	6.521E-02	5.710E+01	2.015E-01	7.242E-06	2.555E-08	3.528E-03
3000	2.193E+01	7.551E-02	6.774E+01	2.333E-01	8.592E-06	2.958E-08	3.443E-03
3000	2.570E+01	8.532E-02	7.939E+01	2.636E-01	1.007E-05	3.343E-08	3.320E-03
3000	4.673E+01	1.819E-01	1.444E+02	5.621E-01	1.831E-05	7.129E-08	3.893E-03
3000	9.256E+01	4.125E-01	2.859E+02	1.274E+00	3.628E-05	1.616E-07	4.455E-03
3000	1.545E+02	6.403E-01	4.774E+02	1.978E+00	6.058E-05	2.509E-07	4.141E-03
3000	2.880E+02	1.506E+00	8.897E+02	4.651E+00	1.129E-04	5.899E-07	5.224E-03
2800	5.132E+00	2.323E-03	1.585E+01	7.176E-03	2.011E-06	9.102E-10	4.527E-04
2800	6.392E+00	3.077E-03	1.975E+01	9.504E-03	2.505E-06	1.205E-09	4.813E-04
2800	1.539E+01	9.465E-03	4.755E+01	2.924E-02	6.031E-06	3.709E-09	6.149E-04
2800	2.013E+01	1.853E-02	6.219E+01	5.725E-02	7.888E-06	7.261E-09	9.204E-04
2800	2.275E+01	1.722E-02	7.027E+01	5.320E-02	8.912E-06	6.748E-09	7.571E-04
2800	2.302E+01	2.068E-02	7.113E+01	6.390E-02	9.022E-06	8.105E-09	8.983E-04
2800	7.163E+01	5.046E-02	2.213E+02	1.559E-01	2.807E-05	1.977E-08	7.042E-04
2800	1.008E+02	5.701E-02	3.115E+02	1.761E-01	3.951E-05	2.234E-08	5.653E-04
2800	3.544E+02	2.690E-01	1.095E+03	8.309E-01	1.390E-04	1.054E-07	7.583E-04
2800	5.111E+02	3.928E-01	1.579E+03	1.213E+00	2.005E-04	1.539E-07	7.675E-04
2600	5.008E+00	1.116E-03	1.547E+01	3.448E-03	1.962E-06	4.373E-10	2.229E-04
2600	7.311E+00	1.712E-03	2.258E+01	5.288E-03	2.864E-06	6.707E-10	2.341E-04
2600	1.162E+01	1.712E-03	3.591E+01	5.288E-03	4.555E-06	6.707E-10	1.472E-04
2600	1.346E+01	4.384E-03	4.157E+01	1.354E-02	5.273E-06	1.718E-09	3.258E-04
2600	7.963E+00	2.133E-03	2.460E+01	6.588E-03	3.120E-06	8.356E-10	2.678E-04
2600	1.989E+01	6.481E-03	6.144E+01	2.002E-02	7.793E-06	2.539E-09	3.259E-04
2600	2.038E+01	7.147E-03	6.296E+01	2.208E-02	7.985E-06	2.800E-09	3.507E-04
2600	1.965E+01	7.690E-03	6.069E+01	2.376E-02	7.698E-06	3.013E-09	3.914E-04
2600	2.359E+01	7.597E-03	7.289E+01	2.347E-02	9.245E-06	2.977E-09	3.220E-04
2600	2.570E+01	7.505E-03	7.939E+01	2.318E-02	1.007E-05	2.940E-09	2.920E-04
2600	2.903E+01	8.175E-03	8.969E+01	2.525E-02	1.138E-05	3.203E-09	2.815E-04
2600	2.601E+01	8.796E-03	8.036E+01	2.717E-02	1.019E-05	3.446E-09	3.381E-04
2600	2.508E+01	9.939E-03	7.747E+01	3.070E-02	9.827E-06	3.894E-09	3.963E-04
2600	8.395E+01	1.994E-02	2.593E+02	6.160E-02	3.290E-05	7.813E-09	2.375E-04
2600	9.485E+01	1.994E-02	2.930E+02	6.160E-02	3.717E-05	7.813E-09	2.102E-04
2600	2.518E+02	5.363E-02	7.779E+02	1.657E-01	9.873E-05	2.101E-08	2.129E-04
2600	2.398E+02	5.701E-02	7.408E+02	1.761E-01	9.402E-05	2.234E-08	2.376E-04
2600	4.579E+02	1.201E-01	1.415E+03	3.710E-01	1.796E-04	4.706E-08	2.620E-04
2600	4.750E+02	1.292E-01	1.467E+03	3.993E-01	1.863E-04	5.064E-08	2.718E-04

# APPENDIX D - COMPARISON OF EXTRAPOLATION PROPERTIES

<i>Temperature</i>		<i>Pressure</i>	<i>Density</i>	<i>Predicted solubility</i>		<i>Pred. sol./reference sol.</i>	
(°C)		(MPa)	(mol/L)	(mol fraction)		(-)	
				<i>SiO<sub>2</sub></i>	<i>NaCl</i>	<i>SiO<sub>2</sub></i>	<i>NaCl</i>
*	350	16.52942	6.306074	1.149E-04	3.589E-05	1.000E+00	1.000E+00
	300	2.24500	0.5	3.182E-07	1.493E-09	2.770E-03	4.158E-05
	300	4.21000	1.0	9.821E-07	1.800E-08	8.548E-03	5.016E-04
	300	5.89600	1.5	1.973E-06	7.970E-08	1.717E-02	2.220E-03
	300	7.30900	2.0	3.343E-06	2.346E-07	2.909E-02	6.536E-03
	300	8.46100	2.5	5.177E-06	5.531E-07	4.505E-02	1.541E-02
	350	2.47400	0.5	6.073E-07	2.672E-09	5.286E-03	7.443E-05
	350	4.71300	1.0	1.935E-06	3.172E-08	1.684E-02	8.838E-04
	350	6.72100	1.5	3.958E-06	1.379E-07	3.445E-02	3.842E-03
	350	8.50600	2.0	6.796E-06	3.976E-07	5.915E-02	1.108E-02
	350	10.08000	2.5	1.063E-05	9.158E-07	9.254E-02	2.551E-02
	350	11.45000	3.0	1.572E-05	1.831E-06	1.368E-01	5.102E-02
	350	12.63000	3.5	2.237E-05	3.322E-06	1.947E-01	9.254E-02
	350	13.65000	4.0	3.099E-05	5.605E-06	2.697E-01	1.562E-01
	350	14.51000	4.5	4.210E-05	8.958E-06	3.664E-01	2.496E-01
	350	15.22000	5.0	5.635E-05	1.372E-05	4.904E-01	3.822E-01
	400	2.69700	0.5	1.159E-06	4.370E-09	1.009E-02	1.217E-04
	400	5.19400	1.0	3.811E-06	5.133E-08	3.317E-02	1.430E-03
	400	7.49300	1.5	7.942E-06	2.206E-07	6.913E-02	6.145E-03
	400	9.60200	2.0	1.382E-05	6.281E-07	1.203E-01	1.750E-02
	400	11.53000	2.5	2.184E-05	1.428E-06	1.901E-01	3.977E-02
	400	13.28000	3.0	3.255E-05	2.815E-06	2.833E-01	7.844E-02
	400	14.87000	3.5	4.665E-05	5.031E-06	4.060E-01	1.402E-01
	400	16.31000	4.0	6.503E-05	8.365E-06	5.660E-01	2.330E-01
	400	17.61000	4.5	8.882E-05	1.316E-05	7.731E-01	3.667E-01
	400	18.79000	5.0	1.195E-04	1.982E-05	1.040E+00	5.521E-01
	450	2.91800	0.5	2.212E-06	6.649E-09	1.925E-02	1.852E-04
	450	5.66100	1.0	7.506E-06	7.753E-08	6.533E-02	2.160E-03
	450	8.23300	1.5	1.594E-05	3.305E-07	1.387E-01	9.206E-03
	450	10.64000	2.0	2.809E-05	9.331E-07	2.445E-01	2.599E-02
	450	12.89000	2.5	4.485E-05	2.102E-06	3.904E-01	5.856E-02
	450	14.98000	3.0	6.741E-05	4.109E-06	5.867E-01	1.145E-01
	450	16.94000	3.5	9.729E-05	7.270E-06	8.468E-01	2.025E-01
	450	18.76000	4.0	1.365E-04	1.197E-05	1.188E+00	3.335E-01
	450	20.45000	4.5	1.874E-04	1.866E-05	1.631E+00	5.198E-01
	450	22.03000	5.0	2.532E-04	2.782E-05	2.204E+00	7.752E-01
	500	3.13600	0.5	4.222E-06	9.548E-09	3.674E-02	2.660E-04
	500	6.11900	1.0	1.479E-05	1.107E-07	1.287E-01	3.084E-03
	500	8.95200	1.5	3.198E-05	4.691E-07	2.783E-01	1.307E-02
	500	11.64000	2.0	5.711E-05	1.316E-06	4.971E-01	3.667E-02
	500	14.19000	2.5	9.213E-05	2.947E-06	8.018E-01	8.210E-02
	500	16.60000	3.0	1.396E-04	5.722E-06	1.215E+00	1.594E-01
	500	18.89000	3.5	2.029E-04	1.006E-05	1.766E+00	2.803E-01
	500	21.06000	4.0	2.864E-04	1.646E-05	2.492E+00	4.585E-01

\* Reference Point

<i>Temperature</i> (°C)	<i>Pressure</i> (MPa)	<i>Density</i> (mol/L)	<i>Predicted solubility</i> (mol fraction)		<i>Pred. sol./reference sol.</i> (-)	
			<i>SiO<sub>2</sub></i>	<i>NaCl</i>	<i>SiO<sub>2</sub></i>	<i>NaCl</i>
500	23.12000	4.5	3.954E-04	2.547E-05	3.441E+00	7.096E-01
500	25.07000	5.0	5.369E-04	3.773E-05	4.672E+00	1.051E+00
550	3.35300	0.5	8.057E-06	1.307E-08	7.012E-02	3.642E-04
550	6.57200	1.0	2.913E-05	1.509E-07	2.535E-01	4.204E-03
550	9.65700	1.5	6.417E-05	6.366E-07	5.585E-01	1.774E-02
550	12.62000	2.0	1.161E-04	1.778E-06	1.011E+00	4.952E-02
550	15.45000	2.5	1.892E-04	3.963E-06	1.647E+00	1.104E-01
550	18.17000	3.0	2.892E-04	7.654E-06	2.517E+00	2.132E-01
550	20.77000	3.5	4.233E-04	1.340E-05	3.684E+00	3.732E-01
550	23.27000	4.0	6.009E-04	2.181E-05	5.230E+00	6.075E-01
550	25.67000	4.5	8.341E-04	3.359E-05	7.260E+00	9.357E-01
550	27.98000	5.0	1.138E-03	4.950E-05	9.905E+00	1.379E+00
600	3.56900	0.5	1.538E-05	1.722E-08	1.338E-01	4.796E-04
600	7.01900	1.0	5.737E-05	1.980E-07	4.993E-01	5.517E-03
600	10.35000	1.5	1.288E-04	8.325E-07	1.121E+00	2.319E-02
600	13.57000	2.0	2.361E-04	2.317E-06	2.055E+00	6.455E-02
600	16.68000	2.5	3.886E-04	5.145E-06	3.383E+00	1.433E-01
600	19.69000	3.0	5.989E-04	9.899E-06	5.212E+00	2.758E-01
600	22.60000	3.5	8.828E-04	1.726E-05	7.683E+00	4.808E-01
600	25.41000	4.0	1.261E-03	2.799E-05	1.098E+01	7.798E-01
600	28.14000	4.5	1.760E-03	4.294E-05	1.532E+01	1.196E+00
600	30.78000	5.0	2.413E-03	6.307E-05	2.100E+01	1.757E+00
650	3.78400	0.5	2.934E-05	2.194E-08	2.554E-01	6.112E-04
650	7.46300	1.0	1.130E-04	2.516E-07	9.836E-01	7.011E-03
650	11.04000	1.5	2.584E-04	1.055E-06	2.249E+00	2.938E-02
650	14.51000	2.0	4.800E-04	2.928E-06	4.177E+00	8.157E-02
650	17.90000	2.5	7.983E-04	6.478E-06	6.948E+00	1.805E-01
650	21.18000	3.0	1.240E-03	1.243E-05	1.079E+01	3.464E-01
650	24.39000	3.5	1.841E-03	2.161E-05	1.602E+01	6.019E-01
650	27.51000	4.0	2.646E-03	3.493E-05	2.303E+01	9.732E-01
650	30.55000	4.5	3.713E-03	5.344E-05	3.231E+01	1.489E+00
650	33.52000	5.0	5.115E-03	7.825E-05	4.452E+01	2.180E+00
700	3.99900	0.5	5.600E-05	2.720E-08	4.874E-01	7.577E-04
700	7.90400	1.0	2.226E-04	3.113E-07	1.937E+00	8.672E-03
700	11.72000	1.5	5.185E-04	1.301E-06	4.512E+00	3.626E-02
700	15.45000	2.0	9.758E-04	3.602E-06	8.493E+00	1.004E-01
700	19.09000	2.5	1.640E-03	7.957E-06	1.427E+01	2.217E-01
700	22.65000	3.0	2.569E-03	1.523E-05	2.236E+01	4.244E-01
700	26.14000	3.5	3.840E-03	2.641E-05	3.342E+01	7.358E-01
700	29.56000	4.0	5.553E-03	4.259E-05	4.833E+01	1.187E+00
700	32.91000	4.5	7.833E-03	6.499E-05	6.818E+01	1.811E+00
700	36.19000	5.0	1.084E-02	9.495E-05	9.437E+01	2.645E+00



## APPENDIX E - SAMPLE SOLUBILITY CALCULATIONS

**Table E-1. NaCl solubility equation.**

$$x = p^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

$$\begin{array}{llll} A = & -7.92886\text{E}+00 & m_1 = & 4.49961\text{E}+00 \\ B = & -4.85247\text{E}+03 & m_3 = & -1.30000\text{E}-03 \end{array}$$

Solubility (mole fraction)

<i>Temperature</i> (°C)	<i>Pressure</i> (MPa)					
	1.0	2.0	3.0	4.0	5.0	6.0
200	3.4657E-11	-	-	-	-	-
300	7.5395E-11	9.6468E-10	4.5680E-09	1.4545E-08	3.7656E-08	8.6585E-08
400	1.2195E-10	1.4671E-09	6.4661E-09	1.8924E-08	4.4320E-08	9.0265E-08
500	1.6203E-10	1.8980E-09	8.1298E-09	2.3077E-08	5.2302E-08	1.0284E-07
600	1.8978E-10	2.1924E-09	9.2564E-09	2.5886E-08	5.7770E-08	1.1179E-07
700	2.0463E-10	2.3450E-09	9.8203E-09	2.7235E-08	6.0266E-08	1.1561E-07
800	2.0868E-10	2.3797E-09	9.9160E-09	2.7362E-08	6.0238E-08	1.1496E-07
900	2.0483E-10	2.3283E-09	9.6708E-09	2.6599E-08	5.8369E-08	1.1103E-07

**Table E-2. SiO<sub>2</sub> solubility equation.**

$$x = p^M \exp(A + DT)/P$$

$$M = m_1 + m_2p + m_3T$$

$$\begin{array}{llll} A = & -2.16047\text{E}+01 & m_1 = & 1.05555\text{E}+00 \\ D = & 1.35587\text{E}-02 & m_2 = & 9.41005\text{E}-02 \\ & & m_3 = & 9.12888\text{E}-04 \end{array}$$

Solubility (mole fraction)

<i>Temperature</i> (°C)	<i>Pressure</i> (MPa)					
	1.0	2.0	3.0	4.0	5.0	6.0
200	3.4808E-08	-	-	-	-	-
300	8.4185E-08	1.3092E-07	1.7530E-07	2.2260E-07	2.7667E-07	3.4208E-07
400	2.1321E-07	3.4521E-07	4.6578E-07	5.8527E-07	7.0896E-07	8.4069E-07
500	5.5015E-07	9.3890E-07	1.2978E-06	1.6495E-06	2.0049E-06	2.3715E-06
600	1.4331E-06	2.5904E-06	3.6896E-06	4.7756E-06	5.8714E-06	6.9926E-06
700	3.7524E-06	7.2003E-06	1.0596E-05	1.4010E-05	1.7484E-05	2.1046E-05
800	9.8515E-06	2.0094E-05	3.0598E-05	4.1396E-05	5.2529E-05	6.4039E-05
900	2.5894E-05	5.6182E-05	8.8603E-05	1.2278E-04	1.5859E-04	1.9603E-04



**Table E-3. Na<sub>3</sub>PO<sub>4</sub> solubility equation.**

$$x = x_{\text{ref}}^* x_{\text{NaCl}}(T, P, \rho) / x_{\text{NaCl}}(T_{\text{ref}}, P_{\text{ref}}, \rho_{\text{ref}})$$

$$x_{\text{NaCl}} = \rho^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

A =	-7.92886E+00	m <sub>1</sub> =	4.49961E+00
B =	-4.85247E+03	m <sub>3</sub> =	-1.30000E-03
T <sub>ref</sub> =	623.15 K	P <sub>ref</sub> =	16.52942 MPa
ρ <sub>ref</sub> =	6.30607388 mol/dm <sup>3</sup>	x <sub>ref</sub> =	2.8000E-07 mole fr.
		x <sub>NaCl</sub> (T <sub>ref</sub> , P <sub>ref</sub> , ρ <sub>ref</sub> ) =	3.8518E-04 mole fr.

Solubility (mole fraction)

Temperature (°C)	Pressure (MPa)					
	1.0	2.0	3.0	4.0	5.0	6.0
200	2.5193E-14	-	-	-	-	-
300	5.4807E-14	7.0126E-13	3.3207E-12	1.0573E-11	2.7374E-11	6.2942E-11
400	8.8649E-14	1.0665E-12	4.7005E-12	1.3757E-11	3.2218E-11	6.5617E-11
500	1.1779E-13	1.3797E-12	5.9098E-12	1.6775E-11	3.8020E-11	7.4757E-11
600	1.3796E-13	1.5937E-12	6.7288E-12	1.8818E-11	4.1995E-11	8.1263E-11
700	1.4875E-13	1.7047E-12	7.1387E-12	1.9798E-11	4.3809E-11	8.4043E-11
800	1.5170E-13	1.7299E-12	7.2083E-12	1.9890E-11	4.3789E-11	8.3571E-11
900	1.4890E-13	1.6926E-12	7.0301E-12	1.9336E-11	4.2430E-11	8.0714E-11

**Table E-4. Na<sub>2</sub>SO<sub>4</sub> solubility equation.**

$$x = x_{\text{ref}}^* x_{\text{NaCl}}(T, P, \rho) / x_{\text{NaCl}}(T_{\text{ref}}, P_{\text{ref}}, \rho_{\text{ref}})$$

$$x_{\text{NaCl}} = \rho^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

A =	-7.92886E+00	m <sub>1</sub> =	4.49961E+00
B =	-4.85247E+03	m <sub>3</sub> =	-1.30000E-03
T <sub>ref</sub> =	633.15 K	P <sub>ref</sub> =	18.66601 MPa
ρ <sub>ref</sub> =	7.987581 mol/dm <sup>3</sup>	x <sub>ref</sub> =	1.5000E-06 mole fr.
		x <sub>NaCl</sub> (T <sub>ref</sub> , P <sub>ref</sub> , ρ <sub>ref</sub> ) =	1.0489E-03 mole fr.

Solubility (mole fraction)

Temperature (°C)	Pressure (MPa)					
	1.0	2.0	3.0	4.0	5.0	6.0
200	4.9562E-14	-	-	-	-	-
300	1.0782E-13	1.3796E-12	6.5327E-12	2.0801E-11	5.3852E-11	1.2383E-10
400	1.7440E-13	2.0981E-12	9.2473E-12	2.7064E-11	6.3382E-11	1.2909E-10
500	2.3172E-13	2.7143E-12	1.1626E-11	3.3002E-11	7.4797E-11	1.4707E-10
600	2.7140E-13	3.1353E-12	1.3238E-11	3.7020E-11	8.2617E-11	1.5987E-10
700	2.9264E-13	3.3536E-12	1.4044E-11	3.8949E-11	8.6186E-11	1.6534E-10
800	2.9844E-13	3.4032E-12	1.4181E-11	3.9130E-11	8.6146E-11	1.6441E-10
900	2.9293E-13	3.3298E-12	1.3830E-11	3.8039E-11	8.3473E-11	1.5879E-10

**Table E-5. CuO solubility equation based on ref. 38.**

$$x = \rho^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

$$A = -9.75084E+00 \quad m_1 = 1.14584E+00$$

$$B = -4.85247E+03 \quad m_3 = -1.30000E-03$$

**Solubility (mole fraction)**

<b>Temperature</b>	<b>Pressure (MPa)</b>					
(°C)	1.0	2.0	3.0	4.0	5.0	6.0
200	4.5568E-10	-	-	-	-	-
300	2.1078E-09	2.4065E-09	2.6430E-09	2.8646E-09	3.0906E-09	3.3351E-09
400	6.0833E-09	6.8370E-09	7.3733E-09	7.8217E-09	8.2259E-09	8.6066E-09
500	1.3103E-08	1.4627E-08	1.5660E-08	1.6483E-08	1.7191E-08	1.7826E-08
600	2.3310E-08	2.5928E-08	2.7658E-08	2.9002E-08	3.0129E-08	3.1115E-08
700	3.6369E-08	4.0372E-08	4.2975E-08	4.4968E-08	4.6614E-08	4.8034E-08
800	5.1678E-08	5.7294E-08	6.0911E-08	6.3654E-08	6.5898E-08	6.7816E-08
900	6.8550E-08	7.5938E-08	8.0666E-08	8.4230E-08	8.7126E-08	8.9588E-08

**Table E-6. CuO solubility equation based on ref. 37.**

$$x = \rho^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

$$A = -1.49399E+01 \quad m_1 = 2.59618E+00$$

$$B = -4.85247E+03 \quad m_3 = -1.30000E-03$$

**Solubility (mole fraction)**

<b>Temperature</b>	<b>Pressure (MPa)</b>					
(°C)	1.0	2.0	3.0	4.0	5.0	6.0
200	3.7936E-13	-	-	-	-	-
300	1.2663E-12	4.1110E-12	8.4941E-12	1.4672E-11	2.3112E-11	3.4593E-11
400	2.8452E-12	8.9139E-12	1.7671E-11	2.9073E-11	4.3225E-11	6.0323E-11
500	4.9729E-12	1.5342E-11	2.9917E-11	4.8361E-11	7.0554E-11	9.6483E-11
600	7.3837E-12	2.2598E-11	4.3701E-11	7.0038E-11	1.0127E-10	1.3722E-10
700	9.8189E-12	2.9912E-11	5.7574E-11	9.1829E-11	1.3213E-10	1.7814E-10
800	1.2088E-11	3.6719E-11	7.0472E-11	1.1207E-10	1.6079E-10	2.1613E-10
900	1.4076E-11	4.2681E-11	8.1763E-11	1.2979E-10	1.8585E-10	2.4935E-10

Table E-7. Cu<sub>2</sub>O solubility equation based on ref. 37.

$$x = \rho^M \exp(A + B/T)/P$$

$$M = m_1 + m_3/T$$

$$A = -2.14219E+01 \quad m_1 = 6.27227E+00$$

$$B = -4.85247E+03 \quad m_3 = -1.30000E-03$$

Solubility (mole fraction)

Temperature (°C)	Pressure (MPa)					
	1.0	2.0	3.0	4.0	5.0	6.0
200	4.6797E-18	-	-	-	-	-
300	6.8329E-18	3.1360E-16	3.2147E-15	1.8093E-14	7.4398E-14	2.5516E-13
400	8.1382E-18	3.4276E-16	3.1793E-15	1.5910E-14	5.6887E-14	1.6475E-13
500	8.3762E-18	3.3991E-16	3.0298E-15	1.4529E-14	4.9630E-14	1.3685E-13
600	7.8662E-18	3.1309E-16	2.7353E-15	1.2847E-14	4.2949E-14	1.1582E-13
700	6.9768E-18	2.7460E-16	2.3719E-15	1.1011E-14	3.6379E-14	9.6927E-14
800	5.9709E-18	2.3340E-16	2.0020E-15	9.2289E-15	3.0274E-14	8.0083E-14
900	4.9983E-18	1.9451E-16	1.6610E-15	7.6224E-15	2.4891E-14	6.5544E-14







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